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A CHART OF THE HUMAN HAIR-STREAMS, SHOWING THEIR LINEAGE AND HISTORY.

By WALTER KIDD, M.D., F.Z.S.

THE interrogation of Nature is the richest seed-plot of science, and those who cultivate it are rewarded in due time if only their foundations be "well and truly laid." Whatever the answers may be, they will never be other than true, and we must needs abide by the result of our interrogation. No oracles are delivered by Nature's voice, rather does she teach by the Socratic method of questioning her learners. Thus it is that, since the genius of Hutton opened up the way into the new world of geology, there are geological problems staring us in the face as we pursue our way on this planet, some inviting or compelling enquiry, some suggesting complicated and, perhaps, hopeless study. It is not less so with biology, which a greater than Hutton has illuminated, and where still the unknown but knowable meets the naturalist on every hand.

To the simpler class of problems belong those facts of the direction of hair on the human body, open to the study of most of us on our own persons or on that of any young hairy subject. Those who have not looked particularly into the matter are not aware that, in addition to the well-known hairy regions, every inch of the human skin is clad with fine hairs, except the palms of the hands, soles of the feet, third phalanges of the fingers and toes, and one or two other small areas. The character of this growth varies from a covering of hairs, so minute that a good lens is needed for their detection, to a profusion of long hair of a Simian character, reaching its maximum in the Ainu or hairy aborigines of Japan.

It is agreed to look upon this hairy covering as a vestige of one which was of use to man's hairy, arboreal, ape-like ancestors, and to consider it as in process of disappearance. Whatever view we may take of its value, it cannot but be subject to natural laws, and the canons of investigation applied to other facts of Nature must be applied in this small instance also.

The rate of growth of the human hair, on the head at least, is an inch in two months, and it is probably less on the general surface of the body.

The hairs are inserted in the skin at an acute angle on every part of the body except the eyelids, where they are at right angles to the surface, and wherever they are found the hair-tracts have a constant direction for that region. This sloping direction of hair is common to nearly all lower animals, the mole being the most marked exception, and the question cannot but suggest itself: Is this slope adapted *to* the needs of the animal or man, or is it adapted *by* their habits? This debatable point cannot be dealt with here.

It is proposed here to study the direction of the human hair-streams and the causation of their various peculiarities. Broadly speaking these streams, according to their range, show two things about man: first, what he has been; secondly, what he has done; or, in other words, his ancestry and his habits of life.

The point which strikes one first in examining the chart of these hair-streams is the very complicated direction taken by them on the head, neck, and trunk, and on the upper extremity, and the equally marked simplicity of the direction of those on the lower extremity. Certain of the former literally demand enquiry as to their cause, on the sound principle that every phenomenon in Nature is to be looked upon as capable of explanation, whether by the light of present knowledge, or by future methods of discovery. It is not necessary to employ hypothesis at all extravagantly or to wait indefinitely for further light in explaining most of these peculiarities in question. They may be open to explanation by one of three hypotheses:—

1. They may have been created with the rest of man's physical frame, as an adaptation to his habits or certain of his needs. This view will hardly commend itself in the light of present knowledge. Apart from other reasons, the direction in which the human hair slopes in the greater part of his body is immaterial to his comfort or well-being.

2. Adaptation and natural selection in the struggle for life might help us. Here, again, the question of utility is involved if such views are to be maintained. It is strange to find such a statement as the following in an important work for students on Physiology by Mr. Leonard Hill, who says without any reserve: "The fine hairs on the body and limbs of man are arranged, as in the monkey,

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to point in certain directions so as to shoot off the rain from the body when climbing."*

This statement is not only contrary to reason but to the facts of the case, as may be seen at once on reference to the figures, *e.g.*, at the back of the neck, the front of the neck, the chest, the back of the trunk, and the outer surface of the arm as far as the middle. These few regions alone are enough to disprove Mr. Leonard Hill's statement.

In considering man's present covering of hair it is not necessary to prove that, except in one or two exposed regions where sexual selection may operate, selectionist views as to the cause of the peculiarities in question cannot hold. If it could be shown that they were survivals of hair-slope useful to Simian ancestors, the case would be different, but a glance at the figures shows this not to be the case, and some other cause for them must be sought.

3. They may have been modified from a simple type of hair-slope through use-inheritance, and this is the view held here.

According to the received view of man's physical descent his prototype must have been Simian in form, partially assuming the erect posture, and perhaps combining some of the characteristics of each of the four genera of existing anthropoid apes.

It follows then that he possessed a hairy covering little differing from that of a gibbon or a chimpanzee. In other words, the primitive stock of man showed a simple and very slightly differentiated covering of hair, whose direction was, broadly speaking, from the cephalic to the caudal end of his trunk, from the proximal to the distal end of his limbs, and on his head the hair-streams either parted in the centre like those of a chimpanzee, or passed backwards from the projecting eyebrows over the low frontal and parietal regions, and fell down his neck in a vertical direction. An hypothetical diagram of this hairy covering may be constructed, and is shown in Figs. A, B. If this representation of the primitive hair-slope of man's early ancestors be not allowed there is an end to the validity of comparative anatomy, and the findings of that great science are set aside in this instance as not agreeing with certain other tenets. But I may safely take it that the direction of hair indicated in Figs. A, B, cannot be challenged except in some entirely unimportant details. There is an illustration in "Living Races of Man," Part IV., p. 110, which is most suggestive on this point, the dorsal surface of the body of a girl two years old being figured and showing a very primitive covering of thick long hair arranged exactly as the hair of a gibbon is arranged, and this would seem to be a reversion to type and a latter-day illustration of the manner in which man's hairy prototype had his hairy covering disposed. The contrast in this illustration between the hair-slope of the case in point and that of man, as we know him, is very striking.

The main tracts of hair on the body of man are represented on the accompanying diagrams and indicated in outline by arrows which point in the direction assumed by the hair-stream of the parts covered by these arrows. Any verbal description of these would be superfluous, and it is only necessary to point out that the diagrams illustrate the normal directions of man's hairy covering, and that these are remarkably constant, whether in the fœtus, as described in 1839 by Eschricht, and 1857 by C. A. Voigt, or in newly-born infants that I have examined, or in hairy young adults, and even in older subjects whose hair has not been worn off by friction. The only difference between the direction of hair in an infant and an adult is that the specially human peculiarities are more pronounced in an adult.

* *See* "Manual of Physiology," p. 324.

These hair-streams may be classified, bearing in mind the direction of hair of man's early ancestors, and its altered direction at the present day, into :—

1. *Primitive*, derived from ape-like ancestor, marked by arrows with single heads ;
2. *Acquired* (A) By morphological change, marked by arrows with two heads ;
   (B) By habit or use, marked by arrows with three heads.

The division of man's hair into separate streams is, of course, an artificial one, but is justified by a reference to the diagrams, which show that the arrows merely indicate the main direction in which a certain tract of hair separates itself from surrounding tracts.

Two considerations must be always kept in mind in studying man's hair-slope: first, that it must be looked upon as a *stream* ; secondly, that in accordance with analogy, *it moves in the lines of least resistance*. As the hairs are set at an acute angle and the rate of growth is about an inch in two months, and as the growth consists in the shaft being pushed out of the hair-follicle by changes there, until its normal length is attained, when the end wears off, there are present just those mechanical conditions needed to produce a *slowly moving stream passing in the lines of least resistance*. The best illustration of this process afforded by nature is a glacier, though the forces in operation are of a different kind, and I would suggest that the direction taken by the hair of man in many regions of his body is governed as much by purely mechanical laws as the windings of a glacier, and is equally far removed from the province of adaptation to needs and selection.

On the *head* the chief peculiarities are correlated with morphological change, except at the edge of the scalp, where varying methods of dressing the hair have availed to produce a remarkable series of peculiarities found even in infants, which cannot be here detailed.* Two are shown in Figs. E, F.

The *face* presents certain changes from Simian type probably due to sexual selection.

The *external ears* conform rather closely to a Simian arrangement.

The *neck* presents in front a remarkable reverse of slope at the level of the larynx (Fig. C), which can only be due to some special human habit or use. It occurs closely at the spot where any clothing worn round the neck terminates, and as may be seen in the neck of a man with a beard not too long, the influence of clothing *does* tend to draw the lower portions of the neck-streams upward.

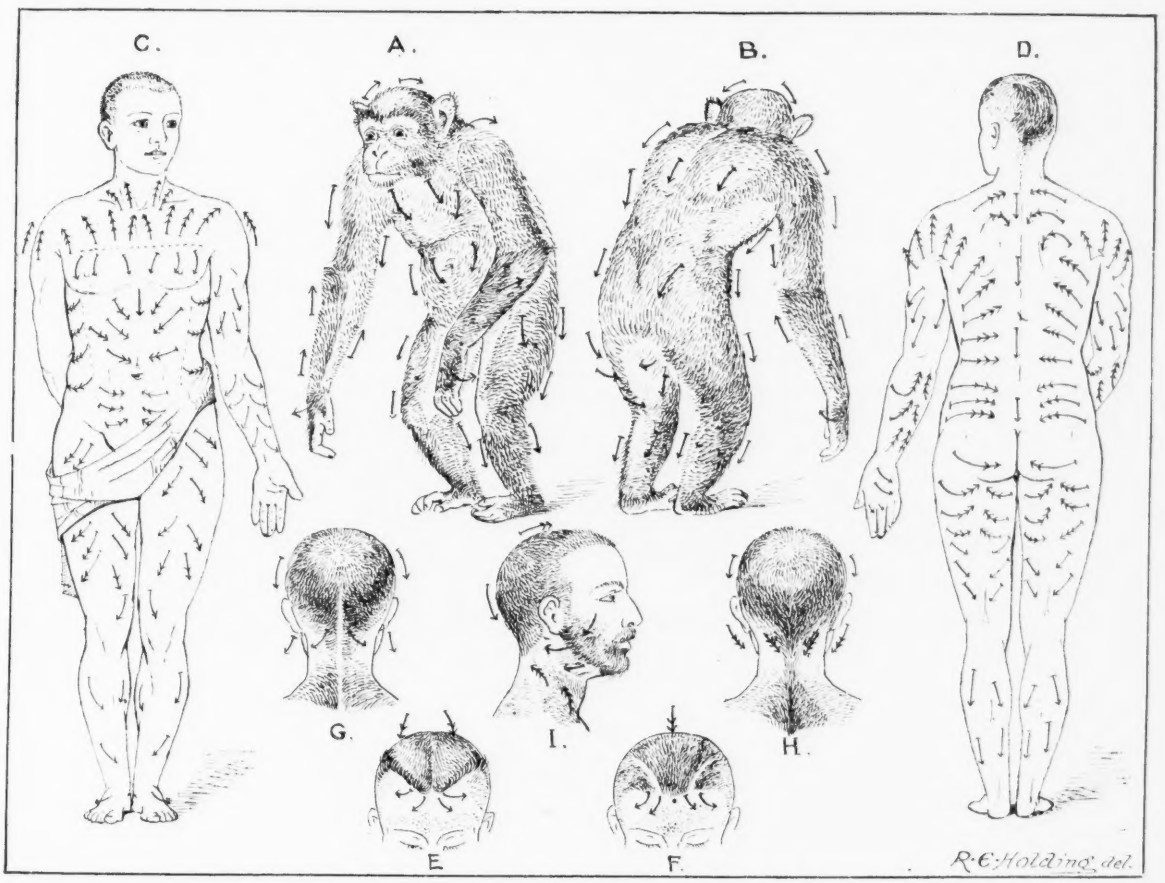
At the back of the neck two well-marked arrangements (Figs. G, H) are to be noted, and these occur about equally frequently in this country in any given number of persons. It would appear that no other cause than varying methods of dressing the hair in this "critical area" of the hair-streams can have produced such entirely non-Simian changes.†

On the *chest* in front a remarkable arrangement is shown in the Fig. C. The point of departure upwards of the streams which go to form those of the neck, is found with singular uniformity at the level of the second costal cartilage or second intercostal space. It is said in Lydekker's "Royal Natural History" that something of this arrangement is found in the gorilla. It is otherwise in the young specimen at South Kensington, and not

* *See Proceedings* of Anatomical Society of Great Britain and Ireland, 1902.

† *See* "Journal of Anatomy and Physiology," Vol. XXXV., pp. 311, 312, 313; and "Use-Inheritance," Walter Kidd. (A. and C. Black. 1901.) pp. 39, 40.

visible in the other three adult specimens. In producing this human peculiarity clothing is probably the efficient cause. It is easy to see that in respiration, which involves much movement of the upper ribs, a force is acting in inspiration and absent when the chest falls in expiration, calculated to draw the growing stream of hair in this, the line of least resistance. Here is an adequate cause acting exactly corresponds to the direction which would be induced by the normal attitude of man in sleep, viz., on one or other side and with the head, and perhaps the shoulder, raised on a pillow. Here, again, as there is a force calculated to produce what we find existing for about a third of a human being's life, it is unnecessary, according to "the law of parsimony," to go beyond such an explanation.



Two views (A and B) of the assumed prototype of Man, showing the primitive direction of hair.

Seven views (C. D. E. F. G. H. I.) of Man's body.—Primitive tracts of hair shown by arrows with single heads.
Those acquired by morphological changes marked by arrows with two heads.
Those acquired by use and habit marked by arrows with three heads.

during two-thirds of man's life, *i.e.*, during daytime, when the effects of pressure against clothing would come into play.

On the lower part of the *chest* and the front of the abdomen such changes as are found are probably due only to morphological change.

The side of the *abdomen* shows the singular parting-line, figured (Fig. C) as extending from the axilla to the level of the umbilicus, here sometimes terminating in a whorl and, in most cases, extending to the groin. This wholly human peculiarity is most probably accounted for by the fact that in sleep on one or other side, which is the greatly predominant attitude, the arm lies along this parting and determines the separation of the abdominal and dorsal streams in accordance with the principle that these flow in the lines of least resistance.

On the *back* the direction of hair in man and his prototype are markedly contrasted. The upward slope shown The equally strange slope of hair which is seen at the back of the arm-pit is also directed in a way which this force referred to would produce. In addition to the mechanics of the position during sleep, the mechanical effect of sitting with the back leaning against any support emphasizes the existing direction on the shoulders and upper part of the back. Our Troglodyte ancestors cannot well have been luxurious persons, but even they must have had many hours of their strenuous lives free enough to lean against the trunk of a tree, the side of a cave, or some bank of earth, and when we come to the case of modern man, the opportunities for such indulgence have been obviously much increased.

On the *upper extremity* the complicated slope of hair strikes one on looking at Figs. C, D. On the upper half and outer side the singular upward direction which begins at the insertion of the deltoid is clearly of the same nature and due to the same causation as the peculiarities

on the back. The lower half and most of the forearm are equally Simian and simple. The only exception on the forearm is the reversed slope on the extensor surface, due, I submit, to the resultant of two forces, a downward and forward one, acting when this part of the limb rests on any object, as it frequently does. This point does not distinguish man much from apes and monkeys, and in all of these groups similar mechanical forces operate to produce it, including in the latter the effect of tropical rain, in their arboreal lives. I have referred at much more length to the causation of this hair-slope elsewhere,* and need only say here that it is more probable that adaptation *by* habits and use is a far more intelligible cause for it than any adaptation *to* the needs of the animal on which selection might act. This peculiarity is found very marked in carnivores, such as a short-haired dog, and ungulates such as certain antelopes, which lie with their fore limbs planted in front of them, in the very attitude calculated to *produce* this slope.

On the *lower extremity* the direction of hairs is as simple and primitive as that on the upper is complicated and acquired. The only area worth noting is the upper third of the back of the thigh, where the effect of the sitting attitude is clearly able to produce the direction indicated. On the rest of this limb so few forces act on the skin surface with any uniformity that it has retained its primitive slope of hair.

It is worth noting that the theory of use-inheritance carries with it the view that the effects of *disuse* are inherited, and this is remarkably illustrated by the way in which in a very hairy subject, the growth of hair on the leg ceases sharply at a point opposite to the ankle-joint. It is difficult to see how any other influence than that of the friction of a shoe or low boot can produce this sudden transition from a hairy leg to a nearly hairless foot. The contrast also in a very hairy man between the great amount of hair on the back of the hand and the appearance of scattered long hairs on the instep of the same subject is most suggestive.

In addition to any interest possessed by these facts, they have a bearing on heredity. The inference to be drawn from them seems to be that acquired characters may, and in this case are, inherited. If the descent of man be what it is claimed to be, he has somehow acquired and transmitted a very remarkable series of changes of hair-direction. It would seem that these can only have arisen through habit, use, and the action of environments, and by disuse, and that any reference of them to selection is estopped. There is no hair-tract of the human body diverging from the ancestral type of slope which has not an adequate and ascertainable mechanical force to which the facts may fairly be attributed.

The illustrative plate has been prepared under my direction by Mr. R. E. Holding, who has greatly assisted my demonstration of the subject.

FORE-LEGS AND THEIR USES.

By E. A. BUTLER, B.A., B.SC.

THE common lobster furnishes one of the best possible illustrations of a curious principle that finds expression in the organization of animals whose body, like its own, is composed of a succession of segments with jointed appendages, or in other words, animals belonging to the great sub-kingdom Arthropoda. The principle in question is that the paired appendages of the different segments, though all constructed upon the same plan, may become so modified in form as to be adapted to the discharge of the most diverse functions. And so we find that in this particular animal these appendages subserve the functions of progression, whether by walking or swimming, of attack and defence, of manipulation and mastication of the food, and of sensation of various kinds. Amongst insects, too, which are equally arthropodous animals, we find that those appendages which have assumed the character of limbs, and are, as a rule, adapted for locomotion of some kind or other, may yet, by still further modification of their form, become well suited for the performance of other functions quite remote from their original purpose. It is the first of the three pairs of legs with which an insect in its adult condition is furnished that exhibit this peculiarity in the greatest degree, and I propose in this paper to consider in detail the varied functions which are discharged by these same limbs amongst British insects.

We may distinguish in these fore-legs six different types, which are generally distinct, not merely in function, but also in shape and appearance. They may be called the ordinary locomotive type, the prehensile, the raptorial, the fossorial, the auditory, and the brush type; or, to put it in other words, insects may use their fore-legs to aid them in walking or running, in clasping and retaining their mates, in catching their prey or in steadying it while it is being devoured, in digging through the soil, and even in listening to insect music, or again, their front legs may be shortened and covered with a dense mass of hairs so as to look like a brush, and to be quite useless for walking.

By far the greater number of insects of course use their fore-legs as they do the other pairs, for locomotive purposes, and we may consider the locomotive as the normal type of leg, and the rest as modifications of this. As we shall have to make frequent reference to the different parts of the leg, it is very desirable that the few technical terms it will be necessary to use should be thoroughly grasped once for all, in order that the rest of the paper may be intelligently followed. What then is the construction of the ordinary locomotive leg? It is composed of five parts (Fig. 1). Beginning where the leg joins the body, we find first, the *coxa*, a joint which varies very much in shape, but always attaches the leg to the general armature or external skeleton, in a cavity into which it exactly fits. The shape of the coxa and the method of its attachment determine the directions in which the leg as a whole can move, and fix the limits of its action. A small joint comes next, called the *trochanter*. This is succeeded by the two main divisions of the leg, viz., the thigh or *femur*, and the *tibia* or shank. Finally we have a set of two, three, four, or five small joints, called collectively the *tarsus*, or foot, and at the end of the last joint there is usually a pair of hooked claws. The tarsus is the only part of the leg that comes in contact with the ground, and its many jointed condition gives it the necessary flexibility for securing firm foothold when the insect is travelling over uneven surfaces, as would usually be the case. At the points of junction of the different divisions of the leg, the bend is successively in opposite directions, just as in our own limbs. Thus the

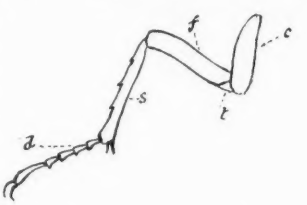


FIG. 1.—Leg of Stag Beetle. *c*, coxa; *t*, trochanter; *f*, femur; *s*, tibia; *d*, tarsus.

* *Proc. Zoological Society*, London, June, 1900, pp. 676–77; "Journal of Anatomy and Physiology," Vol. XXXV., p. 319; "Use-Inheritance," pp. 28–33.

femur bends up from the coxa and trochanter, the tibia bends down from the femur, and the tarsus bends up again from the tibia, so that the angles caused by the bending are alternately on opposite sides of the leg. The figure shows this very well.

A little thought will show that the exact method in which these legs are used must differ according to the position of the leg on the body. Roughly we may say that the fore-leg pulls the body forward, while the hind-leg pushes it, and the middle one serves as a sort of pivot or balancing point. The general rule in walking or running seems to be that the first and third legs of one side, and the middle one on the other, are put forward simultaneously, or nearly so, for the first step, and then are followed by the other three for the next, so that the insect proceeds by means of two tripods which are planted on the ground alternately. In taking a step forward therefore, the right fore-leg, say, will be advanced, and with it or immediately after it the left middle leg and the right hind leg. In advancing the fore-leg, however, the limb is of course stretched out to the full, and as the body moves forward, the joints of the legs close up. The reverse is the case with the hind leg. This is in the contracted condition at the beginning of the step, and is opened out as the step proceeds, thus of course acting as a thrust behind, while the fore-leg exerts a pull in front.

As a rule these movements are effected with very great rapidity, so that the eye can hardly follow them, and hence it is no easy matter to verify the above statements by merely watching a moving insect. A good deal of patience and mental concentration is required to watch six moving objects simultaneously, and determine the order of their movement, even when it is not very rapid, and in most insects it is far too rapid to admit of a determination in this way. If, for example, the observer were to try the experiment on a kitchen cockroach, following it about and keeping his eyes steadily upon it all the time, he would probably be conscious merely of a dazing motion, tiring to the eye and defying analysis, and his patience would be exhausted long before he could satisfy himself as to the true scheme of progression. But by photographing the insect at exceedingly short intervals of time, a minute fraction of a second in fact, on a revolving film, a series of silhouettes is obtained of the different phases of a single step; this is evidently equivalent to a slowing down of the movement till it can be followed with the eye, and thus it is possible to determine the order in which the legs are advanced and progression takes place.

Our second type of leg is that which may be described as the prehensile one. This is a sexual characteristic confined to the males, and is found fully developed only in a small number of insects. The foot is converted into a sort of clasping organ, and, in fact, becomes a kind of hand, by which the suitor is able to secure and retain his mate. In certain water beetles the method of adaptation is that of a great expansion of the basal joints of the tarsus, whereby a kind of suction pad is formed which is sometimes of great beauty and delicacy of construction. The most remarkable and beautiful example is that of the great carnivorous water beetle (*Dytiscus marginalis*). In the male of this insect (Fig. 2, A) the three basal joints of the tarsi are enormously broadened and made to fit close together so as to form a circular pad. On the upper surface there is nothing very remarkable about this except its size; it looks as though the insect had been a martyr to rheumatism or gout, and so had got its joints swollen beyond recognition. But on the underside these pads are marvels of complexity and grace. Their surface is very thickly set with what appear to be extremely modified hairs. Two of these form circular cup-shaped discs, the largest of which is about $\frac{1}{25}$ inch in diameter. The circumference of the discs is margined with fringed hairs. The rest of the surface is closely covered with very much smaller trumpet-shaped hairs, which are present in considerable numbers, and the whole pad is thickly fringed with simple hairs round its edges. All this collection of trumpets, cups, and fringes acts as a complex sucker, and

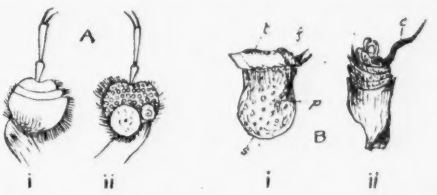


FIG. 2.—A. Fore-foot of male *Dytiscus*. (i) Upper-side. (ii) Under-side.

B. Fore-leg of male *Crabro cribrarius*. (i) Tibia. (ii) Tarsus. *t*, tibia; *s*, shield attached to tibia; *f*, thigh; *p*, projection from thigh beneath the shield, appearing faintly through it; *c*, claw.

adheres to the back of the female insect, the surface of whose wing-covers is roughened by longitudinal furrows, and thus rendered easier to hold. Another very common water-beetle, flatter and rounder in shape, and called *Acilius sulcatus*, is furnished with similar fore-feet, but these two, with perhaps another common *Dytiscus*, are almost the only insects commonly met with that possess this peculiar apparatus.

In the great black vegetarian water beetle, *Hydrophilus piceus*, a slightly different arrangement occurs; its fore-feet are modified, it is true, and for similar purposes, but in a different way. Here it is the last tarsal joint that is enlarged, and not the basal ones. This last joint forms a great triangular disc, but it is not furnished with trumpets and suckers.

Amongst the order Hymenoptera, a very peculiar modification may be seen in certain species of the so-called "sand-wasps." *Crabro cribrarius* is one of the most remarkable of these. It is a shining jet-black insect with its body banded with bright yellow; it is commonly found in sandy localities, where it forms its burrows in the ground, and in the cells it constructs for the rearing of its brood, it stores up flies of different kinds as food for the young larvæ which will in due course be hatched from its eggs. The male of this insect has so extraordinary a pair of fore-legs (Fig. 2, B) that when one first sees them one finds it difficult to believe that the insect is not suffering from a deformity, and it is only on noticing the distinct outlining of the different parts and the exact correspondence of the two legs, that one becomes convinced that one is dealing with a natural structure. The whole length of the leg is affected more or less, and every joint is modified in some extraordinary way. The thighs are short and swollen, and produced behind into a most fantastic, five-sided and rather twisted projection, near to which is a sharp spine. Then the tibiæ are expanded all along their outer edge, so as to make a large shallow cup like a shield, the surface of which is discovered, on holding it up to the light, to be a kind of network with the meshes filled in for the most part with a dark, but here and there with a transparent membrane; the aforesaid projection from the thighs runs into the hollow of this shield, and looks as though it were intended as a support for the latter; the tarsi again are much dilated, and they terminate in two unequal claws, the inner one of which is very long and curiously twisted. The whole apparatus is about as remarkable and complicated as anything to be found

throughout the Insecta. Several other insects, closely allied to this one, are modified more or less in the same manner, each one, however, with a pattern peculiar to itself.

The third type of fore-leg is what I have called the raptorial, by which is meant that the peculiar formation of the fore-legs has regard not to locomotive requirements, but to the capture of living prey. In several instances the fore-legs are used for this purpose without any special modification of form. This is notably the case with the group of water bugs called "skaters," which may be seen any day sitting on the surface of a pool, with their thin long median and hind legs outstretched and ready to start off at a moment's notice, skating over the water out of harm's way. These two long hinder pairs of legs are set on at right angles to the axis of the body and in a horizontal plane, in which the whole of their movements take place, but the fore-legs, which are much shorter, are set on in the usual way, and as the insect sits upon the water, balancing itself by its outstretched skating legs, its short fore-pair rest with their tarsi only on the surface. And here we see the advantage of having three pairs of legs. Two pairs are quite enough to steady the animal on the water and keep it in position, and then the third pair is available for any other duties, for in fact, these fore-feet seem to be as useful as hands. By rubbing the antennæ and beak between them, these important organs are kept clean and tidy, and further, these same limbs are useful for seizing the flies and other small insects that frequent the surface of the pond, and holding them in position while their juicy bodies are being drained dry by the sharp beak of their captor. No particular modification of form is requisite in such a case.

But the water scorpions, which live at the bottom of the pond, and could not conveniently manage in the same way, have their fore-legs very remarkably altered both in form and in the direction in which they can move. As one of these insects was described in our last paper, we may now take as our illustration its much commoner relative, the Common Water Scorpion (*Nepa cinerea*). This is an abundant insect in almost any pond, at least in England. It cannot possibly be mistaken; the extreme flatness of its body, the curiously curved shape of its fore-legs, and its long tail filaments will enable it to be recognised at a glance. The first peculiarity we notice about the fore-legs (Fig. 3) is that they move horizontally, and hence would

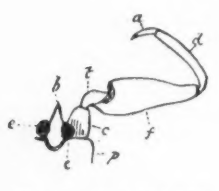


FIG. 3.—Head and Fore-leg of Water Scorpion. *b*, head; *e*, eyes; *p*, thorax; *c*, coxa; *t*, trochanter; *f*, femur; *d*, tibia; *a*, tarsus.

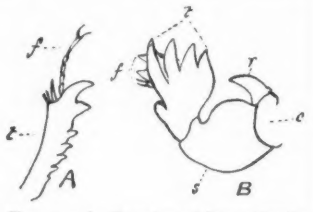


FIG. 4. A. Fore-leg of Dung Beetle. B. Ditto of Mole Cricket. *c*, coxa; *r*, trochanter; *s*, femur; *t*, tibia; *f*, tarsus.

be useless for walking purposes; this change in direction, however, gives them a splendid power in the seizure of prey, for, working from side to side as they do, their ends meet in the middle and grip as by a pair of pincers any object that happens to lie between them. The coxæ are stout and strong and project from the body straight forward on each side of the beak. The trochanter is much larger than usual and serves to turn the corner so as to enable the next part of the leg to stretch out sideways. The femur is by far the largest and longest part of the leg, and its inner edge carries a distinct groove, the use of which will appear presently. The tibia and tarsus together are only as long as the femur, and they are so placed as to curve round from the end of the femur towards each other, so that they can meet straight in front of the head. When not in use they are folded inwards along the edge of the femur, fitting most accurately into the groove aforesaid, just in the same way as the blade of a pocket knife shuts back into the handle. The tarsus itself ends in a sharp-pointed claw. Such is the limb which by slight alterations of form has been transformed from a simple harmless walking implement into a murderous weapon by which living creatures can be seized and brought to the mouth, while their juices are abstracted by the short and sharp beak.

The next type of leg is the fossorial, or digging, one. Many insects that burrow in the ground use their jaws for nibbling away the earth, but others employ their legs, and particularly the fore-pair, in scooping out the soil and so working their way along, and there are certain modifications of structure by which a fossorial leg can always be easily distinguished. The many-jointed foot would of course be too yielding to serve as the digging implement, and hence the duty is handed over to the next part, viz., the tibia, or shank. In digging insects the tibia is strong and stout, and furnished on the outer edge with very hard and powerful tooth-like projections. It is chiefly amongst the order Coleoptera or beetles that these digging legs are found, and they attain their most characteristic development in the group of dung-beetles (Fig. 4, A)—hard-bodied insects that inhabit the droppings of horses and cattle, and are most useful as scavengers. They habitually lie buried in the dung, and their digging legs are of great assistance to them in working their way into and through the mass. In the case of the largest examples, such as the "Watchmen," or "Dor" beetles, these legs further aid in an elaborate process of well-sinking, which is needed for the proper location of the eggs. Beneath the mass of dung, the female beetle excavates a deep and very accurately formed cylindrical burrow, at the bottom of which she places a store of the dung together with one of her eggs. This is destined to hatch in about a week's time, and the young grub therefore finds itself started in life with a well-furnished larder, the contents of which it can proceed lazily to enjoy.

In all these digging beetles, the tarsi are a good deal reduced in size and enfeebled in power, and one can readily understand the possibility of their ultimately becoming practically useless, and so being more or less aborted, for as the tibiæ increase in size and power, the insect would depend more and more upon them and less and less upon the tarsi, which, indeed, might, it would seem, get in the way of the digging operations. Such a stage as this has, in fact, been reached in another insect, belonging to quite a different order, the mole-cricket (*Gryllotalpa vulgaris*), a member of the Orthoptera. This insect is as well adapted for burrowing as the little quadruped from which it gets its name, and the modification of the fore-limbs has, in the two cases, proceeded on similar lines. In the mole-cricket (Fig. 4, B), the tibia is enormously broad and strong, and ends in four very powerful teeth which give it the appearance of a hand, and it forms as good an excavating implement as the wonderful hand of the mole itself. The muscles required to work this powerful implement need safe lodging and strong attachment, and hence the femur too is widely dilated, and is almost as stout and strong as the tibia. On the other hand, the tarsus has dwindled away to a most insignificant size, and has been shunted on one side where it lies underneath the tibia; in fact, it is not likely to be noticed at all except on close inspection,

and the leg seems to end with the tibia, on which, of course, the insect walks.

One of the strangest and most unexpected of the uses to which we could imagine a leg as being put is that of an organ of hearing. Yet such seems to be one at least of the functions of the fore-legs in the cricket and some other allied insects. On the outer side of the tibia (Fig. 5)

FIG. 5.—Fore-tibia of House Cricket. *a*, auditory organ.

FIG. 6.—Fore-leg of Tortoiseshell Butterfly. *f*, femur; *t*, tibia; *s*, tarsus.

a small oval space may be seen in which the strong armature which covers the rest of the body is reduced to a thin and membranous condition, making thus a sort of window or drumhead. Communicating with this, inside the leg, are the ends of a nerve, and it can hardly be doubted therefore that the whole apparatus constitutes an auditory organ, so that if these legs were amputated, the insect would become deaf. When one remembers that crickets are amongst the noisiest of insects, their incessant chirrup being a most shrill and penetrating sound, it cannot be considered strange that distinct organs of hearing should also be present; the sound-producer implies the sound-perceiver; the two functions are complementary; but still it is remarkable that the fore-leg should have been selected as the most suitable site for this important sense.

Our last type of leg scarcely deserves the name of leg at all, as it is shrunken in size, and does not reach the ground. It is met with in certain butterflies, which, so far as walking is concerned, move about on four legs only instead of the usual six. The Common Tortoiseshell Butterfly will serve very well to illustrate this peculiarity.

Here the fore-legs (Fig. 6) are much shorter than the other two pairs, though composed of the usual parts. Their whole surface is thickly covered with long hairs which project beyond the end of the foot, and thus effectually prevent it from being used to rest upon, and the whole limb has the appearance of a sort of dusting brush. These small brush-like legs lie folded up on the breast, and their hairiness so effectually conceals their form that they are with difficulty distinguished from the general fluffiness by which they are surrounded; hence at first sight the butterfly appears to be really a four-legged insect, and it is only on poking about carefully amongst the hairy mass that the apparently missing pair are discovered.

A NEW ALGOL VARIABLE. +43° 4101.

A STRIKING illustration of the value of the library of glass photographs collected at this Observatory during the past seventeen years has been shown within the last few days. Comet 1902A was discovered by Mr. Brooks on April 14th, and it was found that a photograph had been taken here on April 3rd with the 8-inch Draper telescope, approximately in the direction from which the comet came. An examination of this plate was accordingly made by Mrs. Fleming, superposing it upon another plate of the same region taken with the same instrument on March 7th, 1900. No trace of the comet was found, and in fact the elements now indicate that it was a little beyond the region covered by the photograph. One star, however, in the constellation Lacerta, according to Heis, but in Cygnus according to the Uranometria Nova, appeared faint on the early plate and bright on that taken later. A further examination showed that this object was the north preceding component of +43° 4101. Its position for 1900 is R.A. = 21h. 55·2m., Dec. = +43° 52′. The difference in right ascension of the two components is about 2·0s., the difference in declination 0′·3. A further examination showed that the star was generally bright and constant in light, so that it must be a variable of the Algol type. It is not very distant from the remarkable variable star SS Cygni, which precedes it 16m., and is 44′ south. This last star was discovered at this observatory in 1896, and is ordinarily faint, becoming suddenly bright at intervals which appear to be irregular. Only one other star, U Geminorum, is known to undergo similar changes. The star, SS Cygni, has been carefully studied here, several hundred photographs having been taken of it. It has also been observed visually on several hundred nights both here and elsewhere, but as yet the law regulating its outbursts of light has not been discovered. Again the advantage of the photographic method is indicated, since each plate taken for SS Cygni can be used for studying the new variable, or any others that may be discovered in this part of the sky, as well as if taken for each alone, while of course the visual observations of SS Cygni can be used for no other star. The total number of plates showing the new variable at full brightness is 388, of which 1 was taken in 1889, 10 in 1890, 12 in 1891, 8 in 1892, 9 in 1893, 3 in 1894, 10 in 1895, 37 in 1896, 184 in 1897, 30 in 1898, 37 in 1899, 28 in 1900, 7 in 1901, and 12 in 1902. Besides these, the star appears on 54 photographs taken with the 2·5 inch anastigmat, but they have not been included in the present discussion, since the proximity of the other component in some cases renders it difficult to decide whether the variable is at its full brightness or not. Besides these plates, 19 were found on which the variable, which ordinarily has the magnitude 8·9, was of the magnitude 9·3 or fainter.

At first the period was thought to be 1·498d., but this was found to be an error. The true period appears to be about 31·304d., and the times of minimum are represented by the formula, 2,410,015·05 + 31·304 E. The star retains its full brightness for 28 days, its photographic magnitude at maximum being 8·9. About a day before the minimum it begins to diminish, attaining the magnitude 9·0 at 1·05d. before minimum, 9·5 at 0·94d., 10·0 at 0·84d., 10·5 at 0·71d., 11·0 at 0·58d., and 11·5 at 0·43. The light remains nearly constant for more than half a day, with the minimum magnitude 11·6. The time of increase is more uncertain, but apparently is nearly the same as that of decrease. The period of this Algol star, 31·4 days, is more than three times that of any other as yet discovered, and the duration of minimum, 2 days, is double that of S Cancri, the next in length. The period of S Cancri is 9·5 days, and the duration of minimum 0·9 day. The last minimum of +43° 4101 occurred on April 28th, 1902, at 21h. 33m., G.M.T. The predicted times of the next minima are May 30d., 4h. 51m., June 30d, 12h. 8m., July 31d., 19h. 26m., September 1d., 2h. 44m., and October 2d., 10h. 2m., 1902.

EDWARD C. PICKERING.

Harvard College Observatory,
May 6th, 1902.

XUM

ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

XV.—NEW STARS.

THE appearance of a "new star" has, in all ages, been felt to be an impressive occurrence. The constellation groupings are so permanent in their character, that to see of a sudden some old familiar pattern amongst the stars changed in its features by the sudden appearance of a new member, a star like the other stars and not a planet, for its place undergoes no change—is so at variance with our ordinary experience, that it is no wonder that our forefathers regarded such an event as partaking of the supernatural. In the times before the telescope—indeed we might go further and say in the times before the spectroscope—such an event brought no information with it. It was impressive, it excited curiosity, but it conveyed scarcely any lesson. The spectroscopic examination of "new stars," on the other hand, has been extraordinarily fruitful, though we are very far as yet from being able to fathom the exact meaning of the facts which we have observed. One thing is clear, namely, that bodies appearing so suddenly as "new stars" have always done, and fading away again so quickly, must differ entirely from the great host of permanent stars. And yet we cannot but feel that the changes through which a "new star" may pass in a few weeks, and the order in which those changes succeed each other, may throw much light upon the changes which have marked in the past, or will mark in the future, the life-history of the more stable members of the heavenly host.

It is this thought which makes the watch for "new stars" of such importance. They offer to us a key, which, however imperfect, is the only one which we can hope to find to unlock the secrets of stellar evolution. And that the "new star" may give us the fullest information within its power, it is essential that it be subjected to the scrutiny of the spectroscope whilst its light is still on the increase. The importance therefore of a stringent watch on the heavens does not lie at all in the *éclat* which will justly attach to the observer who is fortunate enough to be the first to detect a stellar outburst, but in the supreme importance that not one of the few short hours during which the star's light is on the upgrade may be unnecessarily wasted.

Such watching is not for the casual star-gazer, nor for the *dilettante* who has never taken the trouble to master the star-groupings and the coming and going of the planets. The planets especially are sad foes to such unqualified aspirants; and just as the "Crab" Nebula, Praesepe, and even the Pleiades, have sent many eager comet-hunters in hot haste to claim a comet medal, so Venus, Mars and Jupiter have inspired hundreds of letters to observatories or to newspapers to draw attention to "the wonderful new star." One of the most amusing instances of the kind was when the discoverer of the pseudo-planet Vulcan announced to the Paris Académie des Sciences his discovery of "a strange object in Leo," which proved to be no other than the planet Saturn.

The first duty, therefore, of the watcher for "new stars," is to work slowly, steadily, and systematically through the constellations till he has made himself thoroughly acquainted with the appearance, brightness, and position of their every member. When he has done this, then night after night it will be his task, whenever the skies are clear enough, to carefully scrutinise all the stars within his view. The labour will be great, but it must be borne in mind that such acquaintance with the heavens and such regular scrutiny of them are necessary for all the varied branches of "Astronomy without a Telescope," so that the watch for "new stars" may well be incidental only to other lines of work. To be the discoverer of a "new star" renders an observer rightly famous, but as the experience of the past fifty or sixty years shows that we cannot hope to record a discovery of the kind more frequently than once in nine years on the average, it is clear that it ought to be made subsidiary to some more fruitful line of research. The systematic eye study of the Milky Way is particularly a form of astronomy which might be combined with it; since it is on the Milky Way, or on its branches, that all the *Novæ* have been found, as the accompanying diagram will show.

The most famous of all "new stars" is, of course, the one which appeared in the constellation Cassiopeia in November, 1572, and which is always associated with the name of Tycho Brahe, since, though he was not actually the first to discover it, he has left us the fullest and most systematic observations of it. It was lost to sight in March, 1574, after having been visible for seventeen months. Thirty years later another "new star" appeared, only less famous than the *Nova* of Cassiopeia. This one was also observed for seventeen months, and is always associated with the name of Kepler, though its actual discoverer was not Kepler himself, but one of his pupils, John Bronowski. Its position was in the right foot of Ophiuchus.

No such brilliant *Novæ* as these have been seen in more recent times, since both stars were reckoned, when first seen, to be brighter than Jupiter; indeed the star of 1572 ranked as equal to Venus when at her greatest brilliancy. The first of those noted in modern times was, like that of 1604, discovered in the constellation Ophiuchus. It was detected by Mr. Hind on April 28th, 1848, and was then increasing in brightness. Four days later it attained its maximum, which only ranked it of the fifth magnitude. The second star of the list was discovered in the globular cluster 80 Messier, which lies between Alpha and Beta Scorpii. The third was detected by Mr. Birmingham at Tuam on May 12th, 1866, when it was recorded as of the second magnitude. It may be doubted, however, whether this star is quite of the same order as the others. It had been observed several years previously as of magnitude $9\frac{1}{2}$, and it still remains visible, being now classed as a variable under the name T Coronæ. Still its outburst must have been very sudden, for Dr. Julius Schmidt, whose acquaintance with the heavens was of the very closest, declared that about two and a half hours previous to Mr. Birmingham's discovery, he had the constellation of the Northern Crown under his observation, but had noted nothing unusual. The next discovery was to fall to his own lot. On November 24th, 1876, he found a third magnitude star had appeared in the constellation Cygnus. This star rapidly faded away, and was only of the fifth magnitude on November 30th. Its spectroscopic history was of intense interest, for, by September, 1877, the light coming from the star was almost entirely monochromatic, and corresponded with that which would be given by a planetary nebula.

The next "new star," discovered independently by a considerable number of observers in August, 1885, was actually involved in a nebula, the great nebula of Andromeda, and was close to the nucleus. This was wholly a telescopic *Nova*, and since that time several other telescopic *Novæ* have been discovered by means of the photographic charts which have been made at the Harvard College Observatory, or at its southern annexe at Arequipa, Peru. But two *Novæ* have been detected besides these, both of which were naked-eye objects, and the history of their discovery is in the highest degree encouraging and

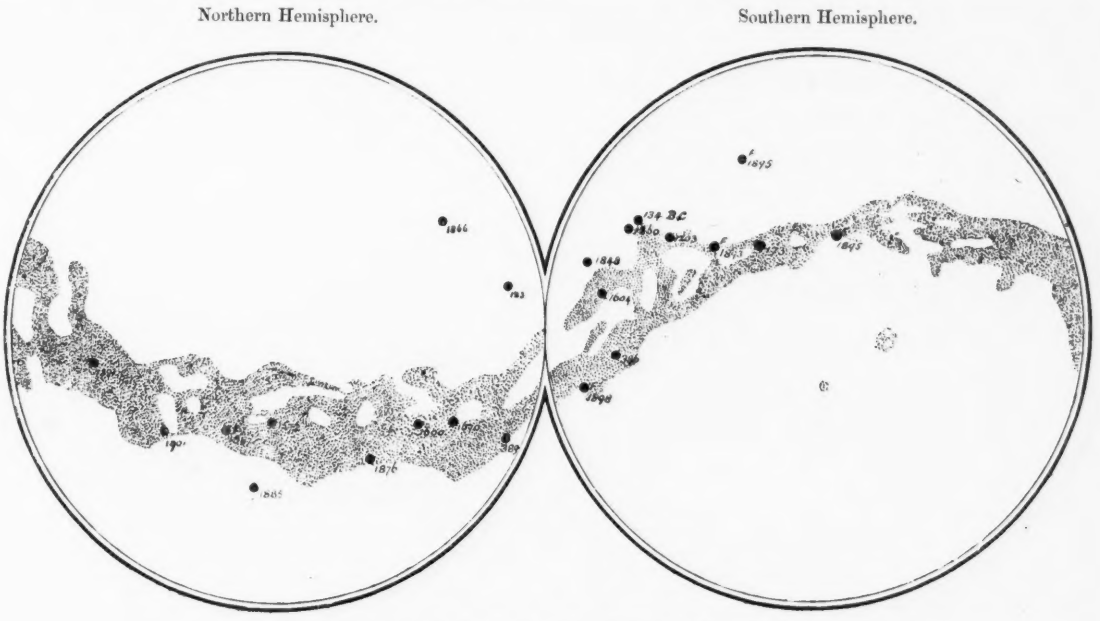
instructive for the "astronomer without a telescope." On February 1st, 1892, an anonymous post-card was received by Dr. Copeland at the Royal Observatory, Edinburgh, with the following announcement:—

"Nova in Auriga. In Milky Way, about two degrees south of χ Aurigæ, preceding 26 Aurigæ. Fifth magnitude, slightly brighter than χ."

That night the star was examined by means of an eye-piece prism at the Edinburgh Observatory, and its spectrum was seen to contain many vivid bright lines, which at once marked it as a "new star" of spectroscopic

the means at my disposal on the morning of the 31st ult., when I made sure that a strange body was present in the sky, were Klein's 'Star Atlas' and a small pocket telescope which magnifies ten tim s."

An examination which Prof. Pickering had made of photographs which had been taken at the Harvard College Observatory of the region of the Nova, showed "that the star was fainter than the 11th magnitude on November 2nd, 1891, than the 6th magnitude on December 1st, and that it was increasing rapidly on December 10th." It would seem to have attained a maximum about December



DISTRIBUTION OF NEW STARS RELATIVE TO THE MILKY WAY.

(The Novæ discovered by Mrs. Fleming on the Harvard Photographic Plates are distinguished by the letter *F* above the date.)

interest, not inferior to the one which had made so great a sensation in 1866. And the anticipations which that first glance gave were much more than fulfilled. Indeed, Nova Aurigæ opened an entirely new chapter in the spectroscopic study of stars of its class; but such study is apart from our present purpose, which cannot be better fulfilled than by quoting the account given by the discoverer, the Rev. Thomas D. Anderson, in a letter which appeared in *Nature*, February 18th, 1892.

"Prof. Copeland has suggested to me that as I am the writer of the anonymous post-card mentioned by you a fortnight ago (p. 325), I should tell your readers what I know about the Nova.

"It was visible as a star of the fifth magnitude certainly for two or three days, very probably even for a week, before Prof. Copeland received my post-card. I am almost certain that at 2 o'clock on the morning of Sunday, the 24th ult., I saw a fifth magnitude star making a very large obtuse angle with β Tauri and χ Aurigæ, and I am positive that I saw it at least twice subsequently during that night. Unfortunately, on each occasion I mistook it for 26 Aurigæ, merely remarking to myself that 26 was a much brighter star than I used to think it. It was only on the morning of Sunday, the 31st ult., that I satisfied myself that it was a strange body. On each occasion of my seeing it, it was brighter than χ. How long before the 24th ult. it was visible to the naked eye I cannot tell, as it was many months since I had looked minutely at that region of the heavens.

"You might also allow me to state, for the benefit of your readers, that my case is one that can afford encouragement to even the humblest of amateurs. My knowledge of the technicalities of astronomy, unfortunately, is of the most meagre description; all

20th, when its magnitude was 4·4. It then decreased slightly for about a month, fading to somewhat below the 5th magnitude. When Dr. Anderson detected it, it was again on the upgrade, and it seems to have reached its maximum about February 3rd, after which it declined. The star therefore had been visible to the naked eye for fully six weeks before Dr. Anderson's discovery, a time when it was evidently passing through the most interesting and important changes. But for his zeal in studying the heavens, it would without doubt have escaped notice altogether, and the spectroscopic revelations which it yielded would have been wholly lost.

This success naturally stirred Dr. Anderson up to making the search for "new stars" his serious business, as he narrates in a most interesting letter addressed to the *Observatory* for March, 1902. He writes:—

"I need hardly say that before the advent of Nova Aurigæ my astronomisings were fruitless—fruitless, that is to say, so far as the rest of humanity was concerned—but far from being fruitless as regarded myself, for there was for me, at least, a certain joyful calm when, after a long evening spent in writing sermons or in other work, I threw up the window, and taking out my little pocket telescope, surveyed the never palling glory of the midnight sky. But after the appearance of Nova Aurigæ the thought occurred to me that perhaps after all 'new stars' might not be such rare phenomena as had up to that time been supposed. The correctness of that surmise has been proved by Mrs. Fleming's discovery since then of no fewer than five of these objects on the Harvard College

photographs, although it is certainly strange that all these *Novæ* should have appeared in the southern hemisphere. I therefore resolved to commence a search for new stars."

Dr. Anderson's purpose was not confined to stars visible to the naked eye, but extended to all stars included in the great work of Argelander and Schönfeld. This necessitated his making charts for himself for the regions south of +40°, a work which meant the plotting down from their catalogue places of more than 70,000 stars. The instruments with which he worked were a large binocular and two refractors, one of $2\frac{1}{4}$ inches, the other of 3 inches aperture, and which respectively enabled him to see stars of the 10th and 11th magnitude. To continue his own account:—

"Thus armed I began to hunt for 'new stars.' I worked with might and main, never going to rest as long as the sky remained clear, and often rising in the night to see if the clouds had passed away, and if they had, hurrying downstairs to begin work either with the binocular or with the telescope. The chief obstacle that I have to contend with in such work is that the only windows in this house from which I can thoroughly examine the heavens, face the north-west. Not only is my field of labour thereby very greatly circumscribed, my telescope being only able to command that part of the heavens which extends from the Equator to +70°, but the discomfort is frequently not inconsiderable, as the northerly and north-westerly winds, which so often bring with them transparent and unclouded skies, are in winter and early spring far from being balmy, and can make themselves felt even when the window shutters are partially closed.

"At first my search was mainly for *Novæ*, and was prosecuted by means of my binocular. . . . When I came to see that hunting for *Novæ* was not attended by the success which I had anticipated, I began, without entirely abandoning such work, to make a systematic search for variable stars. For this I used my $2\frac{1}{4}$-inch telescope, comparing what it showed me with the representation of the heavens contained in the B.D. charts. . . . . I was always glad if after three or four months of searching, during which I might have examined perhaps 20,000 stars and suspected fifty or sixty of variability, I was able at last to come across one whose brightness changed.

"I found Nova Persei, I need hardly say, without either binocular or telescope when I was casting a casual glance round the heavens."

It was then no mere happy chance that the Council of the Royal Astronomical Society were honouring, but the most persistent and strenuous work, when at the annual meeting of February, 1902, they conferred upon Dr. Anderson the Jackson-Gwilt Medal. The words of the President to him, when presenting the medal, put the case briefly and clearly.

"Nova Aurigæ was discovered by you on February 1st, 1892, when of the 4th magnitude, and but for your discovery it might have escaped observation. Nova Persei was discovered on February 22nd of last year at 2.40 a.m., when of 2·7 magnitude and low down in the sky. This early discovery of yours made it possible for Pickering to obtain its spectrum before its maximum was reached. It is no small matter to have discovered one of these *Novæ*, but it is a veritable *tour de force*, such as *à priori* would have seemed impossible to have discovered both, and I am delighted that we have the opportunity to congratulate you on your success and to do honour to your astronomical zeal and intimate knowledge of the sky."

One point with regard to the discovery of Nova Persei deserves further mention, namely that Dr. Anderson's discovery was made almost simultaneously with the outburst, for photographic records show that so late as February 19th the star must have been fainter than the 11th magnitude. It had probably only entered the ranks of stars visible to the naked eye a very few hours when Dr. Anderson remarked it. But it is gratifying to remark that whilst, but for Dr. Anderson, Nova Aurigæ would have passed entirely without detection, the closer watch which is now kept upon the sky resulted in several entirely independent discoveries of Nova Persei. Herr F. Grimmler discovered it the same morning at Erlangen; Captain P. B. Molesworth at Trincomali was not quite twelve hours after Dr. Anderson, and four hours later still Mr. Ivo Carr Gregg, at St. Leonards, had also detected it, and communicating his observation to Col. E. E. Markwick, the Director of the Variable Star Section of the British Astronomical Association, the other members of that Section were made aware of the event before the news of Dr. Anderson's discovery had reached them through the ordinary channels of information.

DISTANT WORLDS.

I.—A REVIEW OF SOME RECENT STUDIES IN STELLAR DISTRIBUTION.

By C. EASTON.

EVERYTHING is relative. This maxim applies to things celestial as well as to things terrestrial. The planet Mars is a distant world, but the distance which separates us from it is insignificant when compared with the abyss which yawns between the sun and the nearest stars: Alpha Centauri, Sirius, Arcturus, which are distant 3, 9, 20 *light-years*. Yet these worlds touch upon us, so to speak, for the confines of our stellar system, of the Galactic system (and perhaps there exist other galaxies in the depths of space), are situated, according to Seeliger, at a distance a thousand-fold greater, at a distance so stupendous that I cannot resist the temptation to express it in kilometres:—

100,000,000,000,000,000.

There is no need for me to insist on the point that this value is not a precise one. Nevertheless, it is based on serious calculations and deductions, and it can at least give some idea of the *order* of distances with which we have to deal when we undertake the study of the Milky Way. As for the number of stars contained in the system, it is probably not less than 60 millions, and is perhaps still greater; so that the total number of stars visible by the naked eye—about 6000—forms only a negligeable quantity of this prodigious sum, and even the 906,000 stars above the 9th or 10th magnitude, enrolled in the "Durchmusterungs" of Argelander and Schoenfeld, of Gill and Kapteyn, constitute but an insignificant fraction.

I have referred to distances and numbers as prodigious as these at the beginning of the article, since they may serve as an excuse for not being yet able to present striking and definite results, when I pass in review what astronomers have found out about the structure of the visible universe in the last four or five years, and both life and progress are rapid in these days. Astronomy, as an exact science, is still young; it cannot venture far from its homestead, the earth, without tottering steps, and the objects which we study here are all near our horizon. How comparatively easy would these researches become if we could transport ourselves for a moment outside the Milky Way, near one of the poles of our stellar system. But the Milky Way surrounds us on all sides, and we are somewhat in the position of a stranger who finds himself suddenly planted on London Bridge, and who tries to study the configuration of the metropolis without being able to climb a tower. He would find some indications to guide him in the trend of the river, the directions of some principal streets, and in the crowd which surrounds him, but for the rest he must trust to the guidance of indirect reasonings. The mind of man is in much the same case when it tries to probe "*Ces fourmilières de l'abîme*," as Victor Hugo calls the Milky Way.

Nevertheless, from what follows, I hope we shall see that our knowledge of the structure of the universe has made real and substantial progress since the epoch—1898—when

Professor Seeliger, of Munich, set himself to again try the "statistical method," that which concerns itself with the apparent distribution of the stars in order to infer from this their real distribution in space.* Seeliger utilised for this the enumeration which he himself made of the stars observed by Argelander, Krueger and Schoenfeld (as far as magnitude 9·5 or 10), beside a research of Celoria, present Director of the Milan Observatory, on fainter stars, then of the gauges of the two Herschels, and of a work which the author of this paper had published some years before on the distribution of stars of different magnitudes in a portion of the Milky Way. There is no need for me to dwell at length on these matters (*see* KNOWLEDGE for August, 1895). I will confine myself to giving as succinctly as possible the conclusions to which the German astronomer has arrived in his researches.

We know that the stars, taken as a whole, become more numerous in proportion as we approach the Milky Way, from which it follows that the phenomenon of the Galaxy is intimately connected with the distribution of the other stars. Seeliger first shows that this progressive increase towards the plane of the Milky Way is not due to the systematic errors in the brightness of stars, which have been established in the Durchmusterung of Argelander. He also shows that this progression is not regular, that the stars of very feeble brightness—fainter than magnitude 11 or 11·5—are distributed quite differently from the more brilliant stars; we find these faint stars in only relatively small numbers near the poles of the Milky Way; within the Galactic zone, on the contrary, they are exceedingly numerous, and the same appears to hold good for stars of a still feebler brightness, such as Herschel's telescope scarcely sufficed to show. All those stars, which appear to us as minute light points, are, for the most part, really confined to the Milky Way. Thus the stellar universe does not seem to be indefinitely extended in the Galactic plane. We can imagine it to be, according to these researches, of a fairly thick lens shape, filled with stars which are much more densely congregated near the edges than near the centre of the lens. Our sun is not precisely at the centre, but neither is it very far removed from it. The southern zone of the Milky Way is probably less rich in stars than the northern zone. These conclusions are not new, but they rest on a large amount of material, and on rigid mathematical development. Seeliger estimates the distance between our sun and the internal border of the zone of stellar condensation (that is to say the Milky Way properly so called) as 500 times the distance of Sirius—the annual parallax of this star is about 0″·37, which places it at 8·8 light-years, or 560,000 semi-diameters of the orbit of the earth—the external border as 1100 times the distance of Sirius. There lie the limits of the stellar system to which the sun belongs. This system reckons probably (according to Seeliger) from 27 to 41 millions of stars down to the magnitude just visible in Herschel's telescope, a magnitude that we cannot fix, but which we can estimate to be of the 13th or 14th.

As for determining more exactly the relative positions of the most crowded regions on the borders of the stellar system—they must not be confused with clusters properly so called, agglomerations of a more intimate nature—Professor Seeliger makes no effort to do so. "It may be a rather vague expression," he says, "to speak of an *annular Milky Way*, but these words indicate fairly well the general distribution of the stars, but nothing hinders us from esteeming certain portions of the Milky Way to be nearer to us, and others more remote, than the average stars of magnitude 9·5 (Argelander), whose distribution in certain parts of the zone presents a remarkable analogy to the situation of the brilliant and dark spots of the Milky Way."

Seeliger does not admit that an appreciable extinction of light can be made sensible in our stellar system. Such an extinction, however, might easily prevent our perceiving other galaxies besides our own, whose existence Seeliger does not presume to deny, although we have no undoubted direct indication of it.

A Russian astronomer, W. Stratonoff, of the Observatory of Tashkent, in Central Asia, has taken a different method of placing in evidence the apparent distribution of the stars.* He follows the cartographic method in continuation of the work of the Italian astronomer, Giovanni Schiaparelli. It was Richard Proctor who especially demonstrated the use of charting in astronomy, and who drew from it important conclusions. Schiaparelli and Stratonoff not only insert on their charts the stars themselves, but for each order of brightness (magnitude 0—6 or 6·5, 6·6—7, 7·1—7·5, &c.) the relative densities of the stars contained in Argelander's catalogue. Then they join by lines portions of equal density, and they obtain charts resembling topographic charts on the earth where the contour-lines mark out the greater or less elevation of the surface. The portions of the sky comprised between these lines are therefore regions where the stellar density is very nearly the same, and for greater clearness these regions are tinted in colours of a depth the more pronounced in proportion as the density is greater; so that the region of the deepest tint has, for a certain stellar class, an extreme density, whilst, on the other hand, regions where the densities are not up to the mean density are left quite white.

It goes without saying that such charts are very useful for showing at a glance where the stars of a certain magnitude are more or less strongly condensed, and that a comparison of the charts will teach us whether there is anything systematic in the manner in which stars are condensed in certain regions—as, for example, in the Galactic zone, according as we take into consideration stars of a feebler brightness. Schiaparelli, in a work published in 1889, took into consideration both hemispheres, but he did not go below the magnitude 6·5—that is to say, almost the limit of stars visible to the naked eye. Stratonoff goes much farther, down to 9·5th magnitude of Argelander, but, on the other hand, he has had to confine himself to the northern heavens. The results of his research are not the less interesting.

We will enter now into the details of the stellar distribution of which Seeliger alone has studied the general features. An inspection of Stratonoff's charts shows us at once that the stars do not cluster towards the entire zone of the Milky Way continuous and uninterrupted as we see it with the naked eye, but principally *towards certain parts* in this bright band. It is as if the stars were attracted particularly towards this region of the Galaxy, and were repelled from that region. For the brilliant stars these places of condensation in the Milky Way are not constant; thus the chart of the stars of the class 0—6·5 show other maxima than those of the class 6·6—7·0; but soon—after about passing the 8th magnitude—the condensation of stars of an intermediate brilliancy preserves in general the same configuration up to the limit of Argelander's catalogue. We find for stars between the 8th and 10th magnitude, maxima of condensation in Auriga and Monoceros, and a minimum in

* Seeliger: "Betrachtungen ueber die räumliche Vertheilung der Fixsterne." München. 1898.

* W. Stratonoff: Public. de l'Obs. de Tashkent, II.; "Etudes sur la Structure de l'Univers." I. 1900.

XUM

Perseus, and pre-eminently a maximum very large and pronounced whose centre falls in Cygnus and which spreads over Cassiopeia and Aquila. Outside the Milky Way the density of Argelander stars, taken as a whole, does not attain to any maximum.

It is worthy of notice that so long as it concerns the relatively bright stars—by comparison with the minute stars which especially produce the optical phenomenon of the Milky Way—the naked eye perceives nothing of the condensations that I have indicated here. The stars visible to the naked eye group themselves especially round Orion and Argo in a zone which makes an angle of 20 degrees with the Milky Way—"the belt of bright stars" recognised and described by Sir John Herschel.

In a second article I will compare the results obtained by Seeliger and Stratonoff, with researches of another order, to draw from them some conclusions on the subject which is now occupying us.

THE "AMERICA" NEBULA IN CYGNUS.

By Dr. MAX WOLF.

HERSCHEL records an exceedingly faint and very extended nebulosity in this place. On the 12th of December, 1890, working with a 5-inch Kranz photographic doublet, I discovered here a very fine and interesting nebula of enormous dimensions, and very bright photographically. As the outlines of the nebula almost exactly resembled those of North America on the map, I called it the "America" nebula. I published a picture of it in KNOWLEDGE for July, 1892. Last year I succeeded in obtaining a photograph of it with my two 16-inch Brashear portrait lenses. The photograph of the two which is otherwise the better has a defect near the middle of the plate; the accompanying reproduction is therefore from the other one. Although it is from the worse negative of the two, it is a very interesting picture, and shows very well the unrivalled beauty of the "finest nebula of the sky." The extent of the nebula from north to south is in all more than three degrees. The bright nebulous star on the right hand (the west) is the star ξ Cygni, and many interesting arms and wings of nebulosity radiate from it.

The centre of the "America" nebula has the co-ordinates:—

R.A. = 20h. 54m. Dec. = 43° 45′ (1855·0).

The plate was by Schleussner; it was exposed for four and three-quarter hours in all on the evenings of July 12th and 13th, 1901. Scale one degree equals about eight centimetres.

Heidelburg.

THE USE OF HAND TELESCOPES IN ASTRONOMY.

By CECIL JACKSON.

IV.—THE STARS.

I will now describe a few objects within the reach of hand telescopes not exceeding two inches in aperture. One of the most striking double stars visible in a 1½ or 2-inch telescope is Mizar (denoted in star-maps by the Greek letter ζ), in Charles's Wain, or the Great Bear.

Fig. 9 shows the position of Mizar in Charles's Wain. There is also another beautiful double star in the adjoining constellation of Canes Venatici. It is marked Cor Caroli in Fig. 9. One of the stars of this double is a beautiful blue, or blue-green. It is a notable fact that if one of the stars of a double is blue the star of this colour is the smaller of the two.

Fig. 10 shows Mizar, as seen with my 1⅝-inch telescope

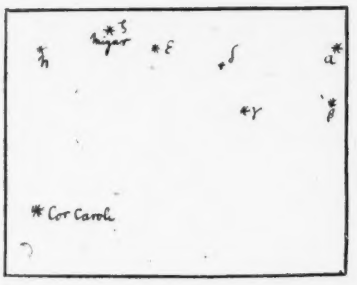


FIG. 9.

FIG. 10.

on Sept. 3, 1892. An astronomical eye-piece of fairly low power was used on the instrument. A power of thirty or thirty-five will readily divide this double star.

Fig. 11 shows the chief stars in Orion, as well as the position of the Great Nebula. This constellation is very easily recognised in the southern sky during the winter months. The Nebula can be seen with a pocket telescope on a dark night.

Fig. 12 gives some idea of the Orion Nebula, as seen in my 1⅝-inch telescope with its own terrestrial eye-piece set to magnify 25 diameters. This sketch was

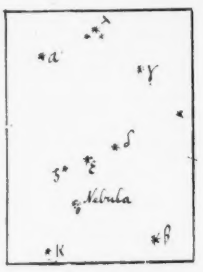


FIG. 11.

FIG. 12.

made at about 5h. 55m. p.m., Jan. 17, 1900. There are many stars near the Nebula, some of which are shown in this sketch. The pair A is worthy of notice.

The group λ is remarkable as seen in the telescope, being then seen to be a triangle composed of three stars. There are also many smaller stars visible in the field of view. The star Betelgeuze (α) is noticeable as

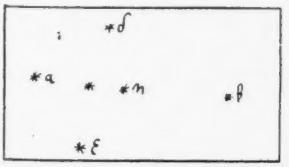


FIG. 13.

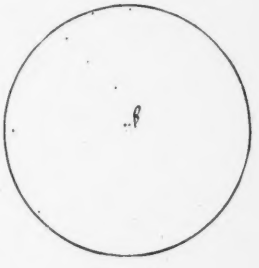


FIG. 14.

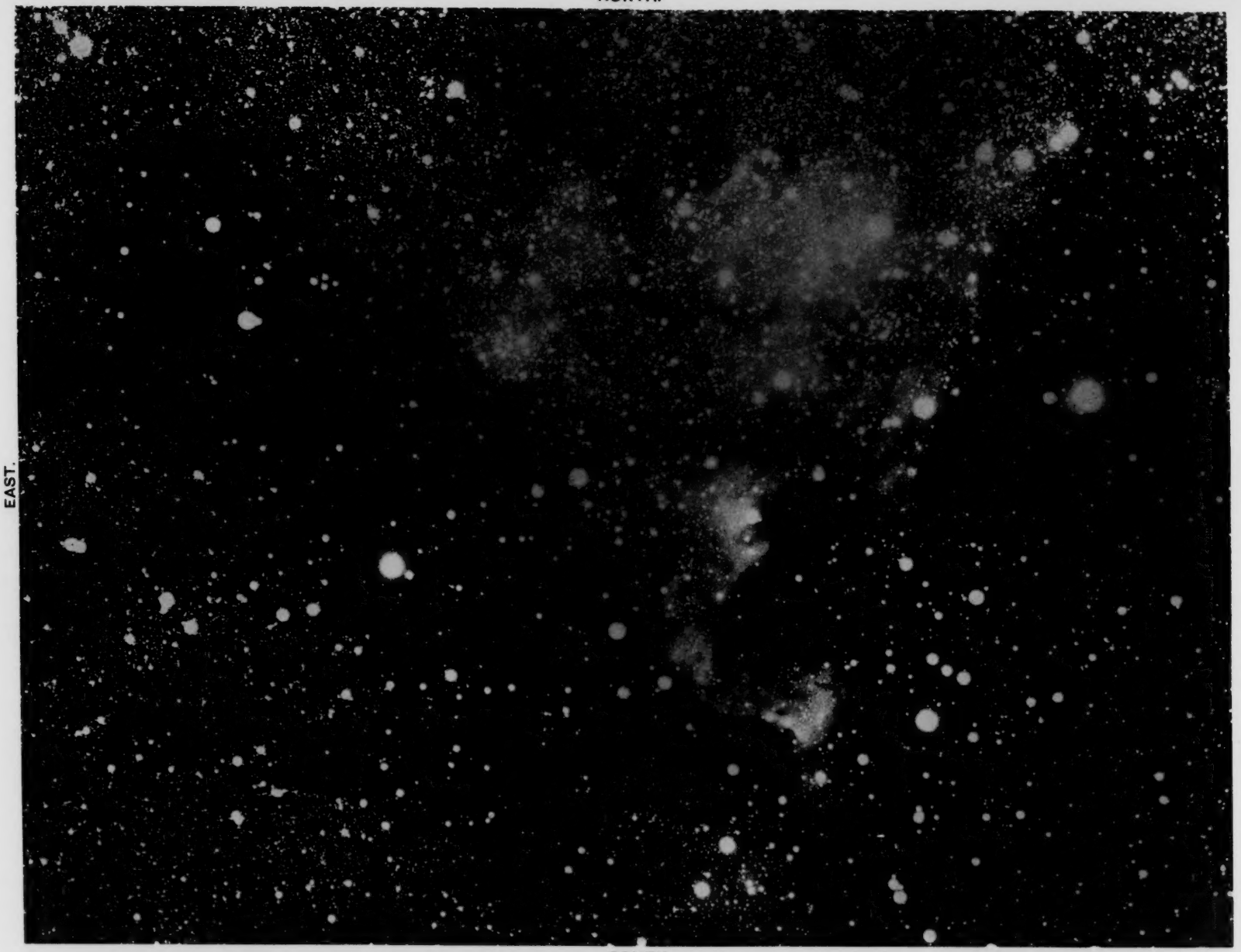
being a reddish star, while the star Rigel (β) is a brilliant white.

Another double star visible in a small telescope is β Cygni. Its position in the Cross in the constellation

XUM

XUM

NORTH.



EAST. WEST.

SOUTH.

THE "AMERICA" NEBULA IN CYGNUS.

Photographed by Dr. Max Wolf, 1901, July 12 and 13. Total Exposure, 4¾ hours.

of the Swan is shown in Fig. 13. The Cross in the Swan is to be seen about overhead when darkness is coming on during the months of July, August, and September.

Fig. 14 shows β Cygni as seen by me at about 8h. 46m. p.m., Aug. 21, 1895. The companion-star of β is a lovely blue colour. For the purpose of observing star-groups it is sometimes desirable to use the terrestrial

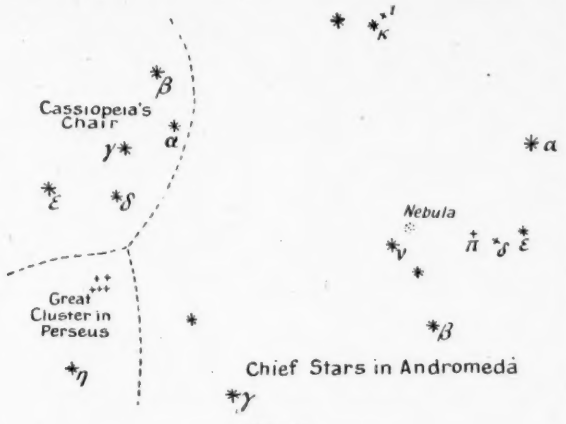


FIG. 15.

eye-piece without the two lenses nearest to the object glass; that is to say, without the erecting lenses. The two lenses nearest the eye-end are to be left in their places. After replacing the eye-piece when the first-mentioned lenses have been removed, the draw-tubes of the telescope will have to be pushed in much further than before in order to get the telescope into focus. By removing the two lenses a large field of view is obtained, but the magnifying power is much lowered, so this method should not be resorted to when observing planets.

Fig. 15—Cassiopeia's Chair, Chief stars in Andromeda, Great cluster in Perseus. Cassiopeia's Chair is on one side of the Pole-star; Charles's Wain on the other. There are very fine fields of stars to be seen in this region in the Milky Way. The cluster in Perseus is a fine sight, especially with a low power on a $1\frac{1}{2}$ or 2-inch telescope.

Fig. 15 shows the chief stars of Andromeda as situated

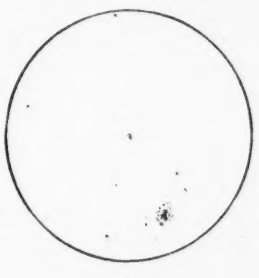


FIG. 16.

with regard to Cassiopeia's Chair. The Nebula will be found by moving the telescope backwards and forwards horizontally in the neighbourhood of the star ν. At the end of each horizontal sweep of the instrument, elevate it a little, and then move it back again, only over a higher strip of sky parallel to, and partly overlapping the first strip. Repeat this process till the Nebula comes into view. You must, of course, make sure of beginning your search *below* the position of the Nebula. By making the strips of sky overlap the chance of missing the Nebula between the sweeps of the telescope is avoided. The Nebula itself is oval, brightest at the centre. This is a sketch of the Nebula made by me at about 5h. 35m. p.m., Saturday, Nov. 16, 1895. My $1\frac{3}{8}$-inch telescope minus the two lenses nearest the object glass was used in making this sketch. The Nebula appears to consist of concentric rings as seen in a photograph of it taken by Dr. Isaac Roberts in Dec., 1888.

The star γ Andromedæ is a double star, the companion being sea-green. The companion itself was found to be double by Otto Struve in the year 1842.

In bringing these notes to an end, I hope I have given sufficient information to induce some to begin to study the wonders of the heavens, even though the instruments at their command may be of so humble a description as a mere hand telescope.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Before we can accept as facts such prodigies of vision as the detection of the crescent of Venus, or of the elongated figure of Saturn, with the unaided eye, we ought to be able to exclude one source of error which is very likely to vitiate such observations, viz., the regular astigmatism of the eye which is present in almost all cases.

The very name of this optical defect serves to indicate the way in which it may lead to mistakes. It was coined by Whewell in order to emphasize the fact that rays of light proceeding from a point do not again unite in a point after passing through a refractive system of the particular kind called astigmatic.

In the human eye the cause of astigmatism is the asymmetry of the cornea, and the direction in which the elongation of a point into a line will take place will depend upon the direction in which the planes of greatest and least refractive power are situated. It is most common to find that the cornea is more strongly curved in the vertical direction, and less strongly in the horizontal, but the rule is not invariable.

If then anyone thinks that he can detect any "elongation" of Venus or of Saturn with the unaided eye, he ought to check his observation, before rushing into print, in the following way, repeating the observation with each eye separately. Let him notice the exact direction in which the elongation is seen. Then, keeping his eye on the star, let him bend his head gradually down toward one side, and let him notice carefully whether the direction of the apparent elongation changes as he does so. When the head is quite down on one side the positions of the two planes of greatest and least refraction respectively will have changed places, since in regular astigmatism they are at right angles to one another in the eye. Accordingly the direction in which the star appears lengthened will be now seen to be at right angles to that of its original lengthening if the elongation is due to ocular astigmatism, and will

not be affected by this change in the position of the head if it is not due to that cause.

R. J. RYLE, M.D.

15, German Place, Brighton.

[Mr. E. Sillence (Romsey) writes to say: "I have no doubt that twice in my life I have seen the crescent of Venus with my naked eye." Mr. Sillence believes that the occasion of these observations was June, 1897, the planet being observed in the bright dawn before sunrise, "so that the usual glare of the planet was gone." The claim that the crescent of Venus has been seen with the naked eye has been made several times, no doubt in the completest good faith. But since—as Dr. Ryle is without doubt right in suggesting—the impression has often been due to astigmatism of the eye, and as in other cases imagination may have been at work, it is essential that before any such claims can be accepted as a scientific fact, the observer should have not only been careful to put on record the exact time and conditions of his observation, but should have been able to show by many experiments, in which the influences of astigmatism and imagination were excluded, that he really possessed the ocular ability necessary to perform so astonishing a feat.—E. WALTER MAUNDER.]

THE DATE OF STONEHENGE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In the May number of KNOWLEDGE Mr. Maunder states that the dates which different careful observers have deduced for the erection of Stonehenge extend over a period of more than 2000 years. While this statement is true if all the derived dates are included, I think it may be worth while to point out that only two of the attempts to determine the date astronomically have been made with a proper grasp of the conditions of the problem and with adequate data—one by Prof. Flinders Petrie in 1881, and the other by Sir Norman Lockyer and Mr. Penrose last year. Other determinations may be left out of consideration, because usually no allowance has been made for refraction and elevation of the horizon, both of which are, of course, important factors in modifying the apparent direction of sunrise. Prof. Petrie's observations were made differentially with evident care, but the date 730 A.D. which he derived cannot be accepted, for the simple reason that in the calculation on which the result is based the variation of the obliquity of the ecliptic was, by a curious slip, applied in the wrong direction. The determination by Sir Norman Lockyer and Mr. Penrose thus practically stands alone, and the date 1680 ± 200 B.C. which they deduced is in as close agreement as can be expected with the 2000 B.C. which Dr. Gowland has since derived from a consideration of the objects found in the excavations.

A. FOWLER.

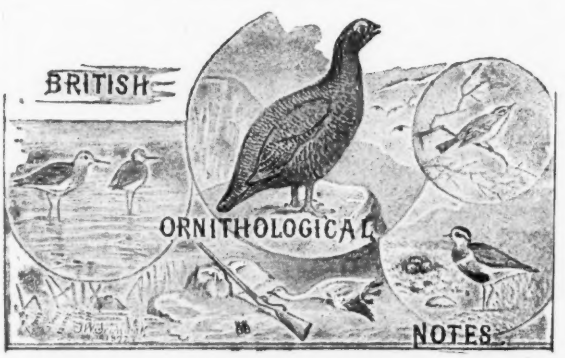
THE SUN PILLAR OF MARCH 6.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—There is one point with regard to the sun pillar which was seen on March 6th which I have seen no notice of anywhere; and so I venture to call your attention to it—perhaps without occasion—viz., the large portion of the country over which it was visible. I cut out letters in the *Times* showing it was visible at Falmouth, Salisbury, and Cranleigh in Surrey. Also at Woking and Guildford and Crawley, Royston, Oxford, Horsham, Hindhead, Botley, Bournemouth, and Braunton (North Devon). These are all below the 52nd parallel. I can, however, add about another degree of northing to that, for I saw it very plainly from here. This means that it was visible over about half of England at any rate. Is it then something cosmical as the sun shining upon a ring of innumerable small bodies in space, and the light being reflected to us; or is it due to a condition of atmosphere extending over hundreds of square miles, and causing each one of us to see his own sun pillar, as he sees his own rainbow?

Pool Quay, Welshpool. R. J. ROBERTS.

[In reply to Mr. Roberts and to other correspondents who have asked for an explanation of the cause of a sun pillar, there can be no doubt that his second alternative is the correct one. A sun pillar is due, not to any cosmical collection of particles outside our own atmosphere, nor to refraction, but to reflection, the reflection that is to say of the sun from the under surfaces of ice films floating horizontally in still air. The phenomenon therefore bears a close analogy to the very familiar one of the "track" of light which we see upon still water when we are looking across it towards a low sun. As each several observer sees his own "track," so each observer sees his own sun pillar. The two phenomena are shown together in the sketch of the sun pillar of January 30th, 1895, drawn by the Rev. Samuel Barber for KNOWLEDGE, June, 1895.—E. WALTER MAUNDER].



Conducted by W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U.

PENGUIN FOOTPRINTS.—At the meeting of the British Ornithologists' Club, held on the 21st of May, Dr. R. Bowdler Sharpe, LL.D., exhibited some remarkable specimens of rocks brought from the Falkland Islands by Mr. Rupert Vallentin. These rocks formed the track from the landing place to the breeding ground of the Rockhopper Penguin, *Catarrhactes chrysocome*, and consequently had been constantly traversed by thousands of birds for countless generations. As a result the surface of the rock had become marked by deep "scores" made by the claws of the birds as they scrambled over its surface. Many larger slabs of rock, showing still better traces of this restless traffic, were taken, but were lost through shipwreck on the voyage home.

THE LIFE-HISTORY OF THE PENGUIN.—An extremely interesting and valuable account of the life-history of the Emperor and Adelia Penguins will be found in the Report of the Southern Cross Collections made during Sir George Newnes' Antarctic Expedition in 1898. Some of the most interesting of these notes possess a peculiarly mournful interest, having been made by the unfortunate naturalist Nicolai Hansen, who died during the expedition. No less interesting are the notes of Mr. Bernacchi. "By far the the largest Penguin rookery seen during the expedition," he writes, "was that of the Adelia Penguin at the foot of

Mount Terror. This rookery was occupied by millions of Penguins. . . . The brown discoloration caused by these birds can be seen some miles off." The nesting place and the eggs of the Emperor Penguin were sought for in vain. It is to be hoped these may at last be brought to light by the "Discovery" expedition now in progress.

Condor laying in Confinement.—The *Zoologist* for May records an instance of a Condor (*Sarcorhamphus gryphus*) which laid an egg on April 10th, at the Natural History Museum, Newcastle-on-Tyne. The bird was brought from the Chilian Andes as a nestling sixteen years ago.

Great Auk's Egg.—An unusually fine specimen of the Great Auk's egg was disposed of at Messrs. Stevens' rooms on May 15th. It realised 290 guineas—only a little below the record price—and has, we believe, passed into the hands of a private collector.

Moulting the Bill in the Wall Creeper.—The *Field* of May 31st draws attention to a tradition to the effect that the Wall Creeper (*Tichodroma muraria*) moults the distal half of the bill in the autumn. There seems to be some evidence to the truth of this, but as yet corroboration is needed. Ornithologists living in London would do well to keep the specimen lately added to the Zoological Society's collection under careful observation during July and August.

All contributions to the column, either in the way of notes or photographs, should be forwarded to W. P. PYCRAFT, *at the Natural History Museum, Cromwell Road, London, S.W.*

Notices of Books.

"SELECTION OF SUBJECT IN PICTORIAL PHOTOGRAPHY." By W. E. Tindall, R.B.A. (Iliffe & Sons.)—This book concerns a branch of photography little heeded by the majority of those multitudes who possess cameras. The walls of two photographic exhibitions are covered annually with examples of well-produced photographs, but among these it is rare to find anything that shows substantial artistic training. This is to be deplored, since fleeting forms of beauty can be seized by the camera in a way denied to the painter—bewildered by rapidly changing expression. And more, for Nature not infrequently casts a picture, totally harmonious, faultlessly composed, and which is sometimes as pleasing in monochrome reproduction as in the doubtful hues imposed by some artists. Mr. Tindall has endeavoured in the book before us to supply this artistic knowledge by illustrating certain laws of composition. His effort scarcely can be called happy. The illustrations, chosen from his own sketches, frequently rely on a mere effect of light for their merit rather than on those subtle and reposeful lines which render the works of a practised artist things of beauty. Plates 3, 7, and 10 are instances of this. Again, to offer a photographer a sketch for his tuition, is to ignore the distinction between the use of a brush and a camera, and this fundamental error renders much of the book valueless. For a beginner, however, those parts of the book which deal with elementary rules of composition, with faults of posture in portraits, and with correct distances to be maintained in figure studies, will be useful. We can further recommend the aspiring photographer steadily to contemplate the title of this book in the hope that by this means a faint impulse in the direction of taking time before the reckless exposure of a plate may be given him.

"THE PRINCIPLES OF INORGANIC CHEMISTRY." By Wilhelm Ostwald. Translated by A. Findlay, M.A., B.SC., PH.D. Pp. xxvii., 785. (Macmillan.) Illustrated. 18s. net.—There are dozens of elementary text books of chemistry, but they can mostly be arranged in two classes, one of which comprises descriptive books which commence by defining elements and compounds, and then pass to the consideration of non-metals and metals in various orders, while the other follows the more reasonable plan of beginning with the study of common substances and chemical changes and making the results obtained suggest conclusions. The latter is the more scientific method, and is the one now adopted in many schools. Professor Ostwald's work belongs to neither of these categories, but stands practically by itself as an authoritative statement of the position of chemical science and philosophy, so far as inorganic substances are concerned. In its pages the methods and results of inorganic chemistry are surveyed in the light of modern theory; so that the book provides the student with a view of the essential facts and interpretations of chemistry as seen from the position of the greatest living exponent of the science. A notable characteristic of the book is the plan of treatment. Theory is made subservient to practical work, and is only introduced when the results described are sufficient to justify theoretical conclusions. Such subjects as molecular weight, or molar weight as Prof. Ostwald prefers to style it, valency, catalysis, and the phase-rule are dealt with in connection with various elements and compounds, according as the appropriate opportunity occurs for considering them. So it is throughout the book; in fact, not until the last chapter are combining weights and the periodic system discussed. Of course the ionic aspects of chemistry receive particular attention, and no student of the science can now afford to neglect them, for the days of chemical atoms and molecules are numbered. The book is one which every teacher and adult student of chemistry should consult, and for this purpose it ought to be added to every public and college library. The illustrations are line drawings, and some of them are quite out of keeping with the general character of the book. Thus no one who reads the book is likely to need the sketches of the measuring flask and jar on page 188, or those of Bunsen burners on page 409. Far better figures are known to every child who learns chemistry nowadays.

"THE JOURNAL OF THE ANTHROPOLOGICAL INSTITUTE," July to December, 1901. Pp. 161-315. "MAN," Nos. 77-153. (London: Anthropological Institute.) 10s. net.—There are thirteen papers in the journal under notice, several of them of great value. In addition, we have a number of original articles and notes in the pages of *Man* bound up with the journal. In the United States or Germany, such contributions to knowledge would be published at the expense of the State, but in England the cost has to be borne by societies or individuals, and the only return is the gratitude of students of anthropology. One of the papers, by the Rev. J. A. Crump, deals with trephining in the South Seas. The natives of some of the South Sea Islands undergo the grave operation of trephining for fractures of the skull, insanity, epilepsy, and even for headache. Though the cavity is cut in the skull with a piece of shell or flake of flint, many of the patients recover. A number of skulls were found in Peru some years ago having holes in them which had evidently been made during life; and Mr. Crump's observations show that primitive men of the present time perform operations like those of which the Peruvian skulls give evidence. Another very interesting paper is by Dr. C. Hose and Mr. W. McDougall on the relations between men and animals in Sarawak. Many of the superstitions described read like stories from a book of fairy tales. Dr. W. H. R. Rivers describes observations made by him in Egypt, and indicating that the Egyptian peasant, like some other peoples, have no name for blue in their vocabulary. Prof. Flinders Petrie shows by pictures from various Egyptian monuments that several distinct types of face can be distinguished, representative of different races. Among the remaining papers are an account, with illustrations, of Irish copper celts, by Mr. G. Coffey, and an illustrated paper on the Lengua Indians of the Paraguayan Chaco. There are many other articles and notes, all of them of interest to students of human races and customs.

"THE SUMMER BIRDS OF FLATHEAD LAKE." By P. M. Silloway. (University of Montana. 1901.) This interesting paper contains some observations on the nidification of the birds recorded, and is illustrated by sixteen plates representing nests and eggs, some of which are admirably reproduced.

"REGENERATION." By Prof. T. H. Morgan, PH.D. Pp. xii., 316. (Macmillan.) 12s. 6d. net. Illustrated.—Biological science is enriched by this profoundly interesting book. There has been so much speculation in connection with organic evolution during the past ten years that a work like Prof. Morgan's, recording results of experiments and observations upon the regeneration of parts of organisms, is as a breeze to a jaded spirit. It has long been known that when certain organisms, such as hydras, are cut in two, each part produces a new individual. An earthworm cut in two can produce two new worms; tadpoles can regenerate their tails; so can lizards and salamanders; shrimps, lobsters, crayfish, crabs, and hermit-crabs can grow their walking legs if they lose their old ones; the beaks of birds will regenerate; and even in mammals some of the internal organs have extensive powers of regeneration. These remarkable instances show the kind of material with

XUM

which Prof. Morgan deals ; and in the accumulation of it, he and his pupils take a foremost place. Everything relating to regeneration, whether in egg, embryo, or adult, is of significance in connection with theories of evolution ; and it is only by the accumulation of knowledge of the phenomena that accurate views of the course of development can be understood. We cannot pretend to show here that this is the case, or to describe the many investigations recorded in the volume under notice, but the following conclusion referring to regenerative changes which are for the good of the organism must be regarded as a statement of the present position of the discussion of the subject :—"The phenomena of regeneration are not processes that have been built up by the accumulation of small advances in a useful direction ; they cannot be accounted for by the survival of those forms in which the changes take place better than in their fellows, for it is often not a question of life or death whether or not the process takes place, or even a question of leaving more descendants. On the contrary, it seems highly probable that the regenerative process is one of the fundamental attributes of living things, and that we can find no explanation of it as the outcome of the selective agency of the environment. The phenomena of regeneration appears to belong to the general category of growth phenomena, and as such are characteristic of organisms. Neither regeneration nor growth can be explained, so far as I can see, as the result of the usefulness of these attributes to the bodies with which they are indissolubly associated. The fact that the process of regeneration is useful to the organism cannot be made to account for its existence in the organism." From these conclusions it will be gathered that Prof. Morgan is not attached to the Darwinian or the Lamarckian schools of biological thought ; and he provides both of them with much material for consideration.

"ATLAS OF PRACTICAL ELEMENTARY ZOOTOMY." By G. B. Howes, LL.D., F.R.S., &c. (London : Macmillan & Co. 1902.) —This volume is a revised edition of the zoological portion of the "Atlas of Practical Elementary Biology," a book well known and highly valued by all the elementary students of biology for the past seventeen years. Little therefore need be said of this revised section. Those, however, who, possessing the complete atlas, imagine that they have no need for the new supplement will make a mistake ; for the plates have been increased to twenty-four in number, and are most exquisitely reproduced. Furthermore, Prof. Howes points out in his preface, the contents of this book have been so modified "as to render it more useful to the teacher than hitherto." The author in his preface makes some pertinent remarks on the relation of lectures to the work in the laboratory, which will doubtless, coming from so weighty an authority, command the attention of all those engaged in biological teaching.

WE have received from Messrs. W. & A. K. Johnston a copy of their New Century Globe, a twelve-inch Terrestrial Globe, showing the Ocean currents, Date line, and Isothermal lines, and having a metal semi-meridian marked in degrees. The Globe is turned out in the good style we always find in Messrs. Johnston's work, and if we resent the discovery of a new island in the North Pacific Ocean as an advertising station for the publishers, it is only because we feel that the same end could be attained without such a disfigurement.

BOOKS RECEIVED.

Aids in Practical Geology. By Grenville A. J. Cole, M.R.I.A., F.G.S. (Chas. Griffin & Co.) Illustrated. 10s. 6d.

Problems in Electricity. By Robert Weber, D.SC. Translated by Edward A. O'Keeffe, B.E., M.I.E.E. (Spon.) 7s. 6d. net.

Mammalia. By Frank Evers Beddard, M.A., F.R.S. (Macmillan.) Illustrated. 17s. net.

Norwegian North Polar Expedition, 1893-1896, Scientific Results. Edited by Fridtjof Nansen. Vol. III. (Longmans.) 32s. net.

Science of Mechanics. By Dr. Ernst Mach. (Kegan Paul.) Illustrated. 9s. 6d. net.

Leibniz.—Discourse on Metaphysics. Introduction by Paul Janet. Translated by Dr. George R. Montgomery. (Kegan Paul.)

Astronomy with an Opera Glass. By Garrett P. Serviss. (Hirschfeld.) Illustrated. 6s. net.

First Steps in Photo-Micrography. By F. Martin Duncan, F.R.H.S. (Hazell.) Illustrated. 1s. net.

Face of Nature. By Rev. C. T. Ovenden, D.D. (Murray.) 2s.

The Primrose and Darwinism. By A Field Naturalist, M.A.(CAMB.). (Grant Richards.) 6s. net.

Physiological and Pathological Chemistry. By G. Bunge. (Kegan Paul.) 16s.

Theology and Ethics of the Hebrews. By Archibald Duff, M.A., LL.D., B.D. (The Semitic Series.) (Nimmo.) 5s net.

Early History of Syria and Palestine. By Lewis Bayles Paton, PH D. (The Semitic Series). (Nimmo.) 5s. net.

Electrical Installations. By Rankin Kennedy, C.E. (Caxton Publishing Co.) Illustrated. 9s. net.

First Course of Chemistry. By J. H. Leonard, B SC. (Murray.) 1s. 6d.

Smithsonian Miscellaneous Collections, 1312, 1313, 1314. (Washington : Smithsonian Institution.)

Recognition of the Fourth Dimension. By C. H. Hinton. (Washington : Philosophical Society of Washington.)

Pioneers of Evolution from Thales to Huxley. By Edward Clodd. (Watts & Co.) 6d.

Toronto Astronomical Society : Transactions and Annual Report, 1901. Edited by Arthur Harvey, F.R.S.C. (Toronto : Z. M. Collins.)

Der Untergang der Erde und die kosmischen Katastrophen. By Dr. M. Wilhelm Meyer. (Berlin : Allgemeiner Verein für Deutsche Litteratur.)

Thornton-Pickard Photographic Specialties. Catalogue, 1902.

Catalogue of Photographic Apparatus. (Sanders & Crowhurst.)

NOTES.

ASTRONOMICAL.—One of the most striking features in the spectra of new stars in their earlier stages is the presence of dark lines on the violet sides of the principal bright ones, one explanation being that which supposes the bright lines to be given out by one body, and t he dark ones by another which has a relatively rapid motion towards the earth. The enormous velocity thus indicated, however, has led some astronomers to believe that the pairs of lines are due to other causes. In experiments on the spectra of electric sparks between metallic electrodes under water, Dr. Wilsing found some time ago what he considered to be similar pairs, and suggested that the phenomena were due to pressure. Sir Norman Lockyer has recently repeated the experiments, and in place of the appearances described by Dr. Wilsing he found, among other things, that some of the metallic lines were reversed ; that is, in place of an ordinary bright line there was a broader bright line with a dark one down the middle. These reversals, however, were unsymmetrical, the less refrangible part of the bright line being usually brighter than the part towards the violet, so that in an under-exposed photograph the appearances noted by Dr. Wilsing might be reproduced. There is, accordingly, no certain evidence of any connection between the pairs of lines in the spectra of new stars and those described by Dr. Wilsing. Similar experiments made by Prof. Hale appear to yield reversals as the principal phenomena.

Reports from Stonyhurst College Observatory indicate that up to February last the spectrum of Nova Persei continued to show the characteristics of a nebula, but whereas the lines in a nebula are sharply defined, those of the nova are in some cases quintuple, and extend over as much as thirty tenth mètres.

In a continued study of the nebula surrounding Nova Persei, Mr. Ritchey, of the Yerkes Observatory, finds

evidence which strongly supports the theory suggested by Kapteyn and others, that the apparent motion is due to changes of illumination in a stationary nebula.—A. F.

BOTANICAL.—The "Flora of Tibet or High Asia" is the title of a long paper by Mr. W. B. Hemsley in the last part of the *Journal of the Linnean Society*. The enumeration of Phanerogams and Ferns shows the flora to consist of 283 species, belonging to 119 genera and 41 natural orders. It is estimated that about 12 per cent. of the species are endemic, but that further research will probably lead to a reduction of this number. The Compositæ are most numerous, there being 53 species, and after them come, in the sequence here given, the Gramineæ, Cruciferæ, Ranunculaceæ, and Leguminosæ, as the most largely represented orders. The flora for the most part consists of very dwarf annual or herbaceous plants, often not exceeding two or three inches in height above the ground, but possessing extraordinarily long tap-roots. Six species are recorded from altitudes of 18,000 feet or more, one, *Saussurea tridactyla*, ascending to 19,000 feet.

In the part of *Hooker's Icones Plantarum* just issued an unusual number of interesting novelties are described and figured, including no less than seven new genera. *Carolinella* (Primulaceæ) is a Chinese plant allied to *Primula*, but having a distinct habit and a circumscissile fruit as in *Anagallis*. *Thomassetia* is an anomalous genus of Ternstrœmiaceæ from the Seychelles, and *Hartia*, belonging to the same order, is from China. The latter is placed near *Stuartia*. *Paradombeya* (Sterculiaceæ) is represented by two species, one from Burma, the other from Yunnan. The flowers of *P. burmanica* are snow-white in a fresh state, but turn yellow in drying. *Diuranthera* (Liliaceæ) resembles *Anthericum*, and differs chiefly in having tailed anthers. This, with the two new genera of Umbelliferæ (*Cryptotæniopsis* and *Carlesia*), are natives of China.—S. A. S.

ZOOLOGICAL.—Specimens of the okapi recently received at Brussels serve to show that the adults of both sexes were furnished with horns, apparently very similar in general character to those of giraffes, being covered with skin. The Brussels specimens comprise the skull of a male and the skin of a female. A small photograph of the skin was exhibited by Dr. Forsyth Major at a recent meeting of the Zoological Society. At the same meeting Mr. G. A. Boulenger showed a strip of skin from the leg of an okapi which had been received in Belgium from Mangbettaland in December, 1899, a year previous to the arrival in this country of the two strips upon the evidence of which *Equus johnstoni* was named.

Another exhibit on the occasion referred to above was a mounted specimen of a wild sheep killed by Mr. J. Talbot Clifton on the mountains bordering the Yana Valley, Siberia, apparently the *Ovis borealis* of Severtzoff, and believed to be the first of its kind brought to England. It was shown to be nearly allied to the wild sheep of Kamchatka, which is itself closely related to the bighorns of North America.

In the June number of the *Zoologist*, Mr. Gunning, of the Pretoria Museum, records the birth of a hybrid between a male ass and a female Burchell's zebra. In general character the mule appears to be much more like its sire than its dam, having no stripes. It is hoped that it may be immune to tsetse-poison and horse-sickness.

The Royal Society has issued the first of a series of reports to the Evolution Committee, describing experiments undertaken by Mr. W. Bateson and Miss E. R. Saunders. These experiments, which have been made both with plants and with poultry, were undertaken with a view of determining whether variations exhibited by animals and plants are distinct phenomena, according as to whether they are continuous or discontinuous. Their result is to fully confirm the truth of "Mendel's Law," of which the essential part is that the germ-cells produced by cross-bred organisms may in certain respects be like one of the pure parental types, and consequently incapable of reproducing the characters of the other. Hence there may be almost complete discontinuity between these germs in respect of one of each pair of opposite characters. This doctrine is likely to have a far-reaching effect on our conception of the origin of species. The experiments are being continued.

STUDIES IN THE BRITISH FLORA.

By R. LLOYD PRAEGER, B.A.

IV.—THE PROTEAN OFFSPRING OF FERNS.

IN my last article the normal forms of our British Ferns were under brief consideration. In discussing the curious phenomenon of apospory, it may have been noticed that, in every instance, this was detected, not in the type form of any species, but in some abnormal variety. The abundance of these varieties in our native Ferns, and their marvellous range of variation, are very remarkable features, well worthy of consideration. In no other group of plants throughout the whole vegetable kingdom do we find such an amazing range of abnormal forms. They are often treated as mere florist's monstrosities, and no more worthy of recognition by the botanist than the rainbow-tinted galaxy of Chrysanthemums or Pansies; but two facts concerning them place them at once on a different footing. First, as many and as remarkable Fern varieties have been found in a state of nature as have been produced by the combined efforts of all the horticulturists; and secondly, a large number of them reproduce themselves absolutely true generation after generation, and are even capable, as we shall see, of carrying (by crossing with other forms) their peculiar characters into other varieties. Furthermore, the features which distinguish these abnormal forms follow certain definite lines even in species of widely separated genera, and are capable of classification. A remarkable point about these Fern varieties is that they are essentially a British group of plants, and their study is a British hobby. While some foreign Ferns yield well-known varieties—such as the crested forms of several species of *Pteris* and Maidenhair—still these are as nothing compared with the wonderful number and range in character of those which have been found wild in our islands, notably in the south-west of England. Another curious point is that the species which are so variable with us appear to lose this character even in neighbouring countries. France and Germany have yielded one or two, but only one or two varieties, where English hedgerows have yielded literally hundreds. These varieties, sports, monstrosities, or whatever we choose to designate them, have occasionally a wide distribution, in which case they frequently obtain recognition from systematic botanists—as *Ceterach officinarum*, var. *crenatum*, *Asplenium Adiantum nigrum*, var. *acutum*, and *Polypodium vulgare*, var. *serratum*, all of which are merely the first stage of the frond-dissection which, as we shall see, is carried immensely further in a number of our common Ferns. In other cases large or small colonies of a variety are formed, as, for instance, *Blechnum Spicant*, var. *trinervium*, which occurs in thousands on the Mourne Mountains in County

Down. But more frequently—and this is a very remarkable fact—a highly abnormal variety, sometimes even one combining *several* quite abnormal features, will occur as a single plant growing amid normal forms, and the most careful search will reveal neither parent nor offspring, in spite of the high fertility of Ferns,* while in cultivation it will propagate freely and preserve its peculiar character. That famous variety of the Lady Fern, *A. F.-f. Victoriæ*, to be presently referred to (Fig. 3), thus occurred in Stirlingshire—a form in which both the cruciate and crested characters are perfectly developed, and are constant in the offspring. The equally remarkable *A. F.-f. Frizelliæ* (Fig. 4), has been twice found—in Wicklow and in Donegal—single plants in both cases, which can have had no connection with each other; and innumerable other instances might be cited.

The various British species differ enormously in their tendency to vary. In the forefront of the variety-producing Ferns stand the Lady Fern, Male Fern, Soft Shield Fern, and Hart's-tongue, each of which has yielded literally hundreds of varieties. On the other hand, the Bracken, Parsley Fern, Scale Fern, and Royal Fern, all of which are at least locally abundant, very seldom depart from the normal character. In the Oak Fern, Limestone Polypody, and many rarer species, varieties are unknown.

Let us now see in what directions variation is most marked, and through what species each type of variation runs. The following classification is somewhat rough and ready, and does not cover all known varieties, but it will serve to convey a general idea of the leading lines along which variation has developed :—

			Characteristic Varieties.
1. Alteration of skeleton	A. Branching		*Brachiatum.*
			Ramosum.
			Cristatum.
			Acrocladon.
	B. Widening		*Deltoideum.*
			Sagittatum (Scol.).
			Trinervium (Blech.).
	C. Narrowing		*Angustatum.*
			Barnesii (L. F.-mas).
	D. Dwarfing		*Crispatum.*
			Congestum.
	E. Truncation		*Truncatum.*
			Peraferens (Scol.).
			Frizelliæ
			Victoriæ (A. F.-f.).
	F. Twisting		*Flexuosum.*
			Reflexum.
			Revolvens.
2. Alteration of soft parts	G. Increase		*Plumosum.*
			Crispum (Scol.).
			Cambricum (Polyp. v.).
			Pulcherrimum.
	H. Diminution		*Rotundatum.*
			Interruptum.
			Concinnum (Blech.).
	I. Sub-division		*Tripinnatum.*
			Divisilobum.
			Cornubiense (Polyp. v.).
			Projectum (Scol.).
			Crenatum (Ceterach).
	J. Murication		*Muricatum.*
			Lineare.
			Supralineatum.

* Mr. Druery has calculated that a well-developed *Athyrium* in his garden bears annually *eleven hundred million* spores.—British Pteridological Society Report, 1896, p. 9.

Any scheme of this kind is unsatisfactory, for while many varieties drop into their assigned places, as many more belong to two or even three of the classes. We shall now take each of the classes in turn, and consider the range of its characteristics through the various British Ferns, and some of its most remarkable examples.

A.—BRANCHING.—This is the best known and most widely distributed of the abnormalities of Ferns, offering a great variety of types and running to a greater or less extent through every British species. The cause of this tendency to branch in Ferns does not appear to have been satisfactorily explained. The branching is of various types, of which four of the more frequent are figured diagrammatically below. Every gradation of branching and

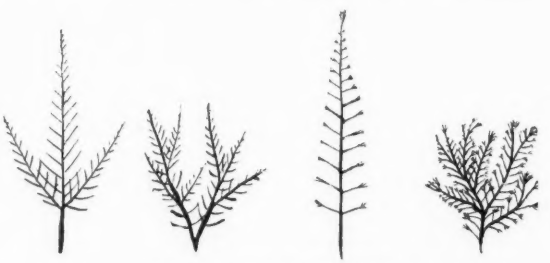


FIG. 1.—Types of Branching.
1. Brachiate. 2. Ramose. 3. Cristate. 4. Ramo-cristate.

cresting occurs, from tiny crestlets at the tips of the pinnæ down to that exhibited by the extraordinary Hart's-tongue known as *glomeratum densum Kelwayi*, in which by excessive branching each frond is reduced to a dense hemispherical mass of parsley-like foliage a couple of inches in height. This last-named form is further remarkable for producing on its leafy surfaces innumerable small buds, analagous to the bulbils borne by the Lesser Celandine or Wood Onion, so that we may break a frond into a hundred pieces and obtain fresh plants from every one by half immersing it in soil. Branching in one form or another has been found in many even of our most refractory ferns—the Holly Fern, for instance, *Lastrea æmula*, *Asplenium lanceolatum*, the Parsley Fern, Royal Fern, and Beech Fern. The reader will remember (*see* p. 116 *supra*) that the remarkable phenomenon of apospory occurs in one of the densely crested varieties of the Lady Fern, the tasselled tips of var. *unco-glomemtum* growing out into prothallia if kept in a damp atmosphere.

B.—WIDENING.—A class of varieties that need not detain us. In some forms of *Polystichum* the frond assumes a triangular outline, owing to the lengthening of the lower pinnæ. Other species exhibit an abnormal development of the lowest pair only, thus approximating to the brachiate form of branching figured above. A good example of this is *Blechnum Spicant*, var. *trinervium*, of which mention has already been made. Here the increase of size is accompanied by a sub-division of the enlarged pinnæ. It is interesting to note that the undivided frond of the Hart's-tongue frequently exhibits this character, the base projecting into two lobes, which in a crested form may be themselves crested.

C.—NARROWING.—Not a common nor conspicuous form of variation. One of the most pleasing Ferns in which it appears is a triple variety of the male Fern, *crispa cristata angustata*, the name of which sufficiently describes its characters.

D.—DWARFING.—The skeleton is sometimes dwarfed

without a corresponding change in the soft parts, so that pinnæ and pinnules are densely imbricate and overlapping,

FIG. 2.—*Blechnum Spicant*, var. *trinervium*, from the Mourne Mountains. One-third natural size.

and a frond which to judge from the stoutness of its stipe or stem ought to be a foot or two in length is crowded into a length of six inches.

E.—TRUNCATION.—An abrupt suppression of certain parts of the frond is not uncommon, and sometimes produces remarkable effects. In many cases a ragged and unattractive form is the result, but on the other hand two of the most interesting of all wild finds belong to this class. These are the varieties *Victoriæ* and *Frizelliæ* of the Lady Fern, both of which have been already referred to. *Victoriæ*, a single plant found in Scotland, is a cruciate-crested variety. In this Fern each pinna is aborted just

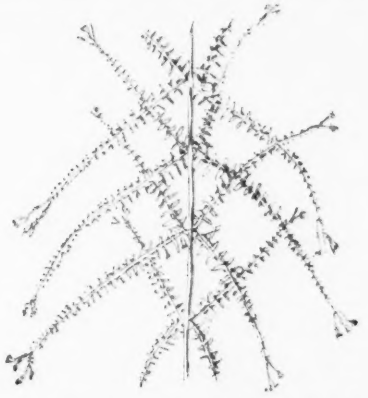


FIG. 3.—*Athyrium Filix-fœmina*, var. *Victoriæ*. Half natural size.

beyond the first pair of pinnules. The latter have consequently the whole burden of food-production, by means of assimilation, thrown upon them, and to get the amount of green surface requisite for this duty these basal pinnules have been enlarged and sub-divided till they almost equal pinnæ in size, and stand out at a wide angle to one another, crossing at right angles those above and below them. The subdivisions of these enlarged pinnules are themselves frequently aborted and cruciate in a similar manner. But in addition, the tips of the pinnæ and frond bear an elegant form of cresting; so that we are lost in wonder as to how this beautifully symmetrical multiple variety can have originated in nature. This cruciate character (Latin: *cruciatus*, crossed) is known in other forms of Lady Fern, and in *Polystichum angulare* and other species, but its combination in the wild state with cresting is unique. *A. F.-f. Frizelliæ* is another of the most remarkable of natural varieties. In this, the secondary rachis, or midrib of the pinna, aborts at or near the second pair of pinnules; the tertiary rachis aborts also, so that instead of a normal pinna we get a tiny rosette of densely crowded and overlapping pinnules, themselves congested and rounded. The result is not easy to describe, but its appearance is shown in Fig. 5. Curiously enough, in spite of all the crowding, the pinnules remain copiously fertile, and have yielded an abundant offspring. In the Hart's-tongue the truncate character appears in a curious manner. The shortened midrib rises out of the surface, and forms a stiff horn, which often overtops the abruptly rounded termination of the lamina.

FIG. 4.—*Athyrium Filix-fœmina*, var. *Frizelliæ*. Top of frond. Half natural size.

F.—TWISTING.—This character sometimes produces forms which might fairly be called monstrous, such as var. *flexuosum* of *Polystichum angulare*, in which the midrib twists so much that the upper half of the frond is frequently reduced to an inextricable ball. But in other cases the result is more interesting. In var. *revolvens*, for instance, of which excellent examples have been found both in *P. angulare* and *L. Filix-mas*, the pinnæ curve uniformly backwards till they meet behind, forming the fronds into arching tubes. The name var. *reflexum* is usually applied when it is the pinnules that curve backwards. Sometimes this is done so completely that the pinnæ form perfect tubes; more often the pinnule is bent backwards both transversely and longitudinally—a common character in the Lady Fern, for instance, when growing in strong light.

G.—INCREASE OF SOFT PARTS.—Into this class come a large number of the most remarkable and most beautiful varieties. While the first stages of development in this direction consist of foliose or very leafy forms, its full development is reached in the *plumosum* type. Here a great expansion of the divisions of the lamina occurs, accompanied by a papery texture and generally by complete barrenness. This type may, indeed, in many ways be considered analagous to double flowers, since in both the production of the sexual generation—the stamens and pistil in one case, the spore and subsequent prothallium in the other—is sacrificed to leafy growth. The plumose character is found in many of our Ferns. It is in the Lady Fern that it attains its most remarkable development, providing a number of forms of glorious beauty, characterized by a wealth of finely-cut delicate foliage. In the Common Polypody the plumose form is represented by the well-known var. *cambricum*, a very leafy divided form. In the Hart's-tongue, the leafy development produces the complicated overlapping frilling which characterizes the *crispum* forms. A most interesting variety which comes also into class G is var. *pulcherrimum* of *P. angulare*; in this the pinnules are prolonged, and, as recently discovered (*see* p. 115), frequently develop prothallia at their tips. Indeed, the greater number of the known cases of apospory occur in varieties of this leafy class, belonging to the genera *Polystichum*, *Athyrium*, and *Scolopendrium*.

H.—DIMINUTION OF SOFT PARTS.—The varieties which come under this head have little of the interest or beauty that pertains to those of the last. Most of them exhibit in irregular diminution or suppression of the pinnules, the midribs of which being sometimes all that remains, standing out like bristles. Sometimes the pinnæ or pinnules are symmetrically abbreviated, with a rounded margin, as in *P. angulare*, var. *rotundatum*, or a frilled margin, as in Mr. Druery's delightful little *Blechnum Spicant*, var. *concinnum*.

I.—SUBDIVISION.—Almost every Fern varies at least slightly as regards the amount of subdivision which its fronds display. This applies particularly to the species with much divided fronds, such as the Lady Fern and Soft Shield Fern, which may be bipinnate, or sub-tripinnate, or tripinnate, or sub-quadripinnate, according to the size and development of the plant. But this normal variation is wholly eclipsed by the surprising abnormal development which not unfrequently displays itself. A few of the more modest variations of this class have, apparently merely on account of frequent occurrence, been admitted as genuine varieties into the British flora. Thus, the fronds of the Scale Fern are normally merely deeply lobed, but when growing strongly the lobes are frequently themselves lobed, and become var. *crenatum*. Similarly with *Asplenium Adiantum nigrum*, var. *acutum*, a well-marked and wide-ranging dissected form, while in *Polypodium vulgare* not only is var. *serratum* admitted, the analogue of which occurs in almost every British fern, but also the plumose form, var. *cambricum*. In *Polystichum angulare* one notable group of varieties comes under this class—the *proliferum* section. The first example of this group was found by Choule, one of the Kew gardeners, over fifty years ago, and was at the time considered to be a foreign fern, so peculiar and well marked were its characters. The frond was elongate, with a very short foot-stalk, tapering upwards from the lowest pair of pinnæ; the pinnules very long and cut into narrow acute pinnules; and the midrib bore buds which developed into young plants long before the frond faded. Fig. 5 contrasts a normal pinna with

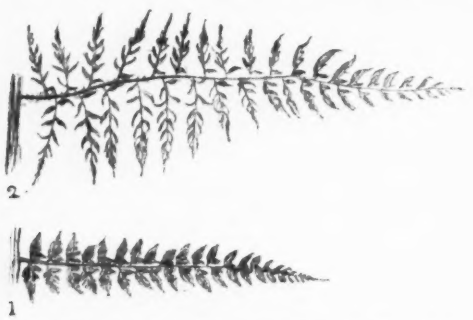


FIG. 5.—Pinnæ of *Polystichum angulare*. 1. Normal form. 2. var. *acutilobum*. One-half natural size.

one from a plant of this kind. Since then many examples of the class have been found, notably in Devonshire, and they have been divided into *acutilobes*, in which the anterior and posterior rows of pinnules are of nearly the same length, and *divisilobes*, which show a striking further development of the posterior pinnules of each pinna. The group furnishes many of the most remarkable, constant and beautiful of the myriad varieties of British Ferns. But it is not only in the Ferns whose fronds are normally much subdivided that striking development by subdivision takes place. Look at the series shown in Fig. 6 of subdivision in the Common Polypody. The type is seen to have pinnæ quite undivided. Then comes var. *serratum*, which leads the way to var. *semilacerum*, and we finally pass to the marvellous var. *cornubiense*, which when fully developed is almost quadripinnate.

J.—MURICATION.—The last group includes those varieties in which the *surface* of the lamina has undergone alteration. It is chiefly in the Hart's-tongues that this character is found. In numerous forms of that species the surface is broken by ridges and knobs of leafy matter, variously disposed. In var. *supralineatum*, for instance, a narrow raised line runs along the upper surface on each side of the midrib for the whole length of the frond. In others the edges are so lacerated that upper and under surfaces are almost indistinguishable, and fructification frequently appears upon the upper surface of the frond.

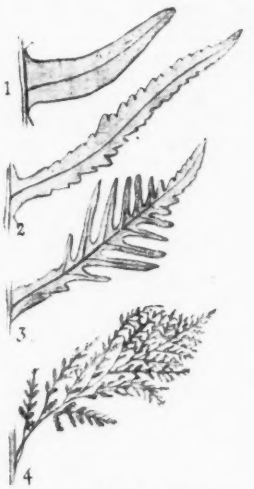


FIG. 6.—Sub-division in the Common Polypody. 1. Normal form. 2. var. *serratum*. 3. var. *semilacerum*. 4. var. *cornubiense*. One-half natural size.

Lastly, a word as to crossed varieties. Repeated experiments have shown that the characters of one variety can be transferred to another by sowing the spores of both varieties together, which involves the inference that the antherozoids of one prothallium may pass to a neighbouring prothallium and fertilize its archegonium. Botanists were very slow at first to admit the possibility of this, but the numerous crosses which now exist prove that it can and does occur. The means by which this cross-fertilization has happened without artificial aid has not been made clear. In some cases no doubt a continuous water medium might exist between two prothallia, while certain experiments of Mr. E. J. Lowe's* point to the probability of carriage by small animals. A useful artificial aid consists of a careful flooding of the prothallia with tepid water when the sexual organs have arrived at maturity. One of the earlier experiments of Mr. Lowe was in itself conclusive. A robust normal form of *Polystichum aculeatum* (of which any cruciate variety was unknown) was sown with a narrow cruciate variety (*Wakeleyanum*) of *P. angulare*. Five out of a thousand seedlings obtained were cruciate *P. aculeatum*, of exactly the type of *Wakeleyanum*.† This experiment, indeed, also proves hybridization between the two species—but it may be held that *P. aculeatum* and *P. angulare* are forms of the same species. With this question we are not concerned. The industry of Mr. Lowe, Col. Jones, Mr. Carbonell, and many others, has now given us a multitude of crossed varieties. By selected sowing, cresting has been thrown into a large number of the most famous varieties, such as *A. F.-f. Frizelliæ* and *P. angulare divisilobum*. *Divisilobum* has been crossed with *plumosum*, giving a Fern of marvellous beauty. Even variegation has been thrown into various varieties, and other peculiar characters, such as the fluxuose, congested, and ramose, have been similarly combined by cross-breeding with well marked and constant forms of other character.

* *Journ. Linn. Soc.* (Botany), Vol. XXXII., p. 531, 1896.

† *See* Lowe, in *Annals of Botany*, Vol. III., pp. 27-31, Plate 3, 1889.

Conducted by M. I. CROSS.

POND-LIFE COLLECTING IN JULY.—Collecting in July is usually not so profitable as one would expect, because as a rule most of the shallow ponds are dried up by this time, or have been reduced to a muddy swamp, and in the others the Crustaceans, Cladocera and Cyclops, have multiplied to such an extent as to leave little room for the more interesting forms of pond-life. This year, however, is likely to prove an exception to the rule, the weather all through the spring having been quite two months behind its usual season.

Pedalion mirum should be looked for in large and small lakes, as it will probably have greatly increased in numbers. The somewhat rare and very large *Asplanchna amphora* and *ebbesborni*, as well as *Asplanchnopus myrmeleo*, are summer forms which occur at this season. Other Rotifers that appear in warm weather are: *Dinops longipes*, *Triphyllus lacustris*, *Notops clavulatus*, *Scaridium eudactilotum*, and *longicaudum*, then the free-swimming *Lacinularia natans* and *Conochilus volvox*, also the fixed *Lacinularia socialis* and *Megalotrocha*, which are found attached to submerged water plants. All these are very beautiful objects under the microscope, but by no means common.

Volvox globator will certainly be found in abundance now in secluded ponds, and inside the green spheres the little parasitic Rotifer, *Proales parasitica*, should be looked for.

The Polyzoa, mentioned last month, will have become more abundant where they occur; undisturbed ornamental lakes and canals are the best places to find them in.

HINTS ON SECTION CUTTING.—Success in microtome section cutting, no matter what microtome be used, can only be properly attained by dexterity in free-hand section cutting. A few directions which will indicate the manner in which this desirable facility may be secured may, therefore, be of value. It calls for patience, care, and considerable practice.

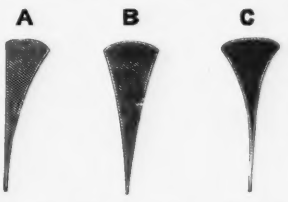
It will be well to select some botanical subjects of small diameter and not too hard in substance to experiment upon, bearing in mind that the smaller the diameter of the material the easier will it be to cut good sections.

The material should be placed in a bottle of 90 per cent. alcohol for three or four days before cutting, and when the operation is in progress, a cup should be provided to receive the razor also containing 90 per cent. alcohol, a saucer with the same spirit in it to dip the material in, and another to receive the sections. A sable-hair brush will also be required of the size known as crow-quill; camel-hair brushes being useless.

The material should be held vertically between the thumb and index finger of the left hand, allowing it to rest in the first bend of the finger and keeping the thumb $\frac{1}{4}$ inch below the level of the finger. The upper end of the material to be cut should be about level with the finger, the razor being held lightly but firmly, chiefly with the thumb and index finger of the right hand. Well wet the material and razor with the alcohol, place the blade of the razor flat upon the index finger of the left hand and cut the thinnest possible transverse section by either drawing the razor towards you diagonally through the material and cutting from heel to point, or by pushing the razor away from you and cutting from point to heel. As each section is cut, it should be lightly brushed from the razor into the saucer of alcohol, and when, say, one hundred sections have been made, the thinnest and best half dozen may be selected and the process repeated for practice. A further selection of the best may then be made.

It may now be well to say a few words on the implements that are necessary.

THE RAZOR.—Three patterns will be found useful for transverse section cutting, as figured A, B, and C. A, being suitable for large objects, or those harder than the average; B, for general use; and C, for small and delicate objects. Quality of steel and sectional shape go hand in hand with form of blade. The edge should be fairly straight and the heel rounded, not angular; the handle should be one that is capable of being grasped properly. Heavy uncouth razors must be avoided; so also should one having any lettering engraved on its blade. The blade should be as broad as possible, $\frac{3}{8}$" being a good width. The razor must be kept free from corrosion, and the edge maintained always at its keenest by careful attention immediately after use.



To set a razor.—The time will quickly come when the edge of the razor will become notched, and in order to restore the edge a hone must be used, a strop being useless for the purpose.

THE HONE.—A very good hone, known as "water of Ayr stone," may be obtained for about 2s. The size of its sharpening surface should be 9 in. by 2 in. Water, not oil, should be used as the lubricant, and it will be found to be a good plan to allow a stream of water to flow continuously over the hone during the whole time of sharpening.

Care should be taken not to scratch the hone. Scalpels, needles, or any other such small instruments should never be allowed to visit it. Having the hone flooded with water, lay the razor flat and diagonally upon the left of the hone in such a manner that the edge of the razor is towards the right, and entirely upon the hone. Draw the razor lightly but firmly edge forwards, and from heel to point along the hone to the extreme right. Turn the razor with a neat action of the fingers combined with a turn of the wrist, its back being kept on the hone, and draw the edge forwards from heel to point as before, from right to left.

Maintain this process to and fro until the notch is removed, remembering always that the lightest pressure will secure the best and quickest results. In fact it is impossible to hone a razor by hard pressure. When the notch is removed by honing, the edge of a razor when carefully examined with a lens × 10 diameters should present throughout its length a straight line, with perhaps here and there a slight fringe or jaggedness standing out from the straight edge, the so-called wire edge. This may be removed by stropping.

The razors, with one side flat, must only be honed upon the concave side, and are more difficult for the novice to sharpen than the other forms. Having dried the razor and returned the hone to its place, we now finish the sharpening by means of the strop.

THE STROP.—Many kinds of strops may be purchased from the dealer. To a new hand the shilling cushion strop will be quite good enough to practise on, subsequently a better strop may be obtained, and the first, although probably damaged by cuts, will be useful for sharpening scalpels. Opinions differ as to the best form of strop, but we have a personal fancy for such as approximate to the following description. A strip of wood, about 13 in. long and $1\frac{1}{2}$ in. wide, has a neat handle shaped at one end, occupying about 4 in. of the length, the remainder forming the base upon which the slightly convex stropping surfaces are built.

Both the stropping surfaces should be of the finest Russia leather. One side is usually charged with the stropping paste, the opposite surface being left bare for finishing. Some strops have the finishing side of buckskin, this we deem wrong for our special purpose, as the velvety buff is apt to impart a rounded edge to the razor. The longer the strop has been in service the better the results obtained, provided that its surfaces have not been hacked. An old friend will have its surfaces hard, smooth and glistening: care should be taken to keep it so. The stropping paste should be applied very sparingly at remote periods and with great care. Black paste should be avoided, as it generally contains emery powder, the red paste is usually of iron-oxide. Good paste can be made by thoroughly mixing the finest jeweller's rouge with the smallest quantity of tallow. Never lay the strop down with either surface in contact with the bench. Avoid belt strops, as the result in inexperienced hands is a rounded razor edge. Holding our ideal strop in the

XUM

left hand, lay the razor flat and diagonally across the prepared surface of the strop, and with a slight even pressure draw it back foremost, and from heel to point from left to right upon the strop, turn the razor with its back upon the strop and pass it from right to left. Maintain the process as in honing, but back of razor forwards. After several dozen strokes upon the paste side, repeat the work upon the finishing side. Draw the edge of the razor between the finger and thumb or through a piece of elder pith. If the sharpening has been accomplished successfully, a power of 80 diameters upon the microscope will show the edge as a straight unbroken line. This microscopic examination is best made by laying the razor upon a sheet of glass. By allowing the handle to form an angle of 45° with the blade the edge will be preserved from injury; another test is to take a hair from the head, and if the razor will cut it at half an inch from the fingers that hold it, the edge is good.

THE USE OF THE BULL'S EYE.—A correspondent sends the following note with regard to the position of the bull's eye in relation to the lamp and microscope:—

I find that the bull's eye has to be placed in a different position when an ordinary round glass chimney is used to that when a metal chimney with a flat slip of glass is employed. This is probably due to the action of the plane and curved surfaces of the chimneys, and can easily be proved by attaching a piece of tissue paper to a slide; this should then be placed on the stage and the image of the flame focussed through the substage condenser on the tissue paper. The bull's eye should then be set at the best position, the effect being watched on the tissue paper. Now, if the chimney be changed, it will be observed that an alteration of about ¼ inch in the position of the bull's eye will be rendered necessary.

To fill the field of a low-power objective with light when using the bull's eye and substage condenser and an ordinary glass chimney with shade, the best results are obtained as follows:—

The bull's eye should be placed at its focal length from flame, and the distance from flame to mirror should be three times the focal length of bull's eye. When using the microscope horizontally without the mirror, the distance from the flame to the substage condenser should be four times the focal length of the bull's eye.

For instance, if the focus of the bull's eye were $2\frac{1}{2}''$ in the former case, the distance to the mirror would be $8\frac{1}{2}''$ from the flame, and in the latter case the substage condenser would be $11\frac{1}{2}''$ from the flame.

It should be remembered that the plane side of the bull's eye should be set towards the flame.

Mr. W. Mence, of Ouse Villa, St. Ives, Hunts., kindly offers to send a limited number of tubes of *Melicerta ringens* on receipt of bottle and postage, and would be glad to have samples of Mycetozoa in exchange.

NOTES AND QUERIES.

A. Vigar.—Diatom slide, with list of names and comments by the gentleman who kindly acts as consultant for this department, has been returned to you by post.

E. E. Morgan.—If you could now conveniently let me have duplicates of the moss specimens you sent at the end of March last, it is likely that I could get them identified for you.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn*, *W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

MR. W. R. BROOKS AND COMETARY DISCOVERIES.—The discoverer of the recent comet may, perhaps, be regarded as the most successful worker in this field of astronomy during the last quarter of a century. Between 1882 and 1892 Mr. W. R. Brooks shared with Mr. E. E. Barnard the honour of finding the majority of new comets, and if we refer to any general summary of results in this department for the period referred to, the names of these able observers will be found to occur with remarkable frequency. But Mr. Barnard relinquished the search some years ago in favour of other important investigations; while Mr. Brooks still devotes himself to it with the same assiduity as ever. In all, he has discovered twenty-three comets, but omitting several objects which were either insufficiently observed, or had been previously detected by other observers, the total number of his discoveries amounts to nineteen. They have ranged over the last twenty years, so that Mr. Brooks's perseverance in sweeping the heavens has furnished us with an average of one new comet in a year. He found thirteen comets with reflecting telescopes of 5 and 9 inches aperture, constructed by himself, and ten comets were first sighted with the 10 inch equatorial refractor at the Smith Observatory, Geneva, New York. Like Messier, Mèchain, Caroline Herschel, Pons, Tempel, Winnecke, Swift, Coggia, Borrelly, and Barnard, Mr. Brooks has laboured with conspicuous success in a field requiring great patience and discernment, and the valuable as well as numerous results he has obtained have been often acknowledged, and will be duly appreciated by posterity. It is singular how the course of cometary discovery is maintained without serious break from one generation to another. As soon as one observer finds it necessary to relinquish the quest there is another ready to take it up; thus the firmament is kept under constant surveillance, and every year provides additional discoveries or marks the recognition of a known periodical comet.

THE COMETS OF THE TEN YEARS 1892-1901.—Altogether forty-eight comets were observed, so that the average number was very nearly five per annum. The total included thirty-four new comets, while fourteen were observed returns of periodical comets. Compared with the preceding ten years (1882-1891), these discoveries exhibit no increase, for there were fifty-two comets well observed during the earlier decade.

JULY AND AUGUST METEORS.—With the return of July meteoric students realize that the eve of an important epoch has arrived. The first half of the month is usually not nearly so productive as the last half, and it is rather unfortunate that in 1902 moonlight will interfere during the fortnight from about July 13th to 27th. With clear weather it will be interesting to look for a number of showers in Pegasus, Cepheus, and Andromeda during the first twelve nights of July, while at the end of the month the Aquarids and Perseids will be pretty certain to furnish a considerable number of meteors. At the latter epoch the moon will rise late, and will have waned sufficiently to exercise little influence on the results. Between about July 28th and August 14th it will be well to follow the Perseid display as closely as possible on every suitable night and count the horary number of meteors, as well as determine the positions of the radiant The maximum of the shower will probably occur before sunrise on August 12th, or just possibly on the following morning.

FIREBALLS.—Several brilliant objects were observed in May, and the following are some particulars:—

May 4, 7h. 35½m.—A pear-shaped meteor of considerable size, and giving as much light as a three or four days' old moon, passed from about 10 degrees S. of the zenith to an altitude of 45 degrees in N.E. Duration about two seconds. Twilight very strong.—E. Rabone, Highgate, N.

This object was seen by another observer in the metropolis, who says it was equal to Sirius, and in the N.E. sky, travelling almost due S. to N. It exhibited a planetary disc of a green colour.

May 16, 11h. 52m.—Fireball equal to Jupiter passed from 212° + 12° to 238° + 23°. Redder than Arcturus. Duration, three seconds. Left a streak.—Rev. W. F. A Ellison, Dublin.

May 26, 10h. 25m.—Meteor nearly equal to Sirius, beneath ρ Scorpii, with scarcely any motion, and only 3 degrees above horizon. Position about 236° − 34°.—Rev. S. J. Johnson, Bridport.

May 27, 12h. 23m.—Splendid meteor starting from hind foot of Ursa Major and falling nearly to horizon at a point directly in line with the direction of the fore foot. Of a green colour, followed by a short track of fiery light. Motion extremely slow. The first appearance of the meteor was not seen; it died away just before reaching the horizon. Nucleus egg-shaped, with apparently a double tail. Path from about 150° + 45° to 125° + 40°, duration 5 seconds.—E. N. Cullum, Brixton, S.W.—The same fireball was fortunately observed by Prof. A. S. Herschel, at Slough, and he gives the time as 12h. 22m., and the apparent brightness as one and a half times that of Venus. A comparison of the pair of observations shows that the radiant point was in Sagittarius at 282° − 24°. The meteor moved from a height of 63 miles, over a point 7 miles E. of Shrewsbury, to a height of 39 miles over the sea 20 miles E.N.E. of Douglas, in the Isle of Man. Length of observed flight 120 miles, and velocity 24 miles per second. These figures are only approximate. Additional observations would be very useful.

THE FACE OF THE SKY FOR JULY.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 3.48 A.M., and sets at 8.18 P.M. On the 31st he rises at 4.23 A.M. and sets at 7.50 P.M. The earth is at its greatest distance from the sun on the 4th at 1 p.m., when the apparent diameter of the sun is 31′ 30″·6.

THE MOON:—

	Phases.	h. m.
July 5	● New Moon	12 59 P.M.
„ 12	☽ First Quarter	12 47 P.M.
„ 20	○ Full Moon	4 45 P.M.
„ 28	☾ Last Quarter	5 15 A.M.

During the month the moon occults two 4th magnitude stars, and approaches very near to another. The following are the particulars:—

Date.	Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Reappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
July 3	δ^3 Tauri	4·2	2 3 A.M.	77	112	2 52 A.M.	264	302	26 20
„ 19	ρ^1 Sagittarii	3·9	10 58 P.M.	30	35	11 54 P.M.	307	303	14 9
„ 22	c^2 Capricorni	6·2	8 54 P.M.	356	33	9 6 P.M.	333	9	17 8
„ 24	12 Piscium	6·5	11 30 P.M.	111	144	12 20 A.M.	203	232	19 10
„ 27	ζ^1 Piscium	4·2	1 21 A.M.	157	192	Near ap	proa	ch	22 12

THE PLANETS.—Mercury is a morning star, at greatest westerly elongation of 20° 35′ on the 16th, when he rises in the N.E. about 2.40 A.M., or about 1h. 20m. in advance of the sun.

Venus is a morning star in Taurus, but is becoming more gibbous and dwindling in apparent diameter. Near the middle of the month she rises in the N.E. about 1.30 A.M., or about 2½ hours before the sun. Shortly after rising on the morning of the 29th, she is near the star μ Geminorum.

Mars is a morning star and rises some two hours before the sun.

Vesta, the brightest of the minor planets, is in Sagittarius, near to 51 and 52 Sagittarii. On the 13th she is in opposition, and during the month she is observable as a 6th magnitude star, having a westerly or retrograde path, as shown on the diagram below.

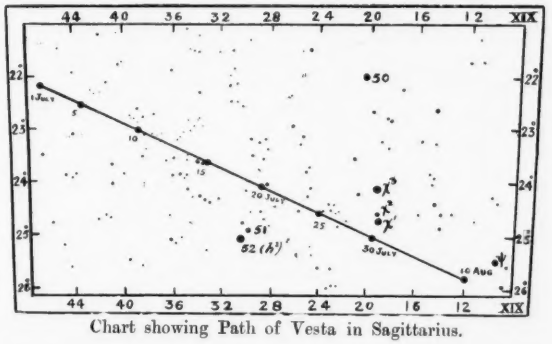


Chart showing Path of Vesta in Sagittarius.

Jupiter now becomes observable before midnight, about which time he is the most conspicuous object looking towards the south-east not very high up. At the beginning of the month he rises about 10 P.M., whilst on the 31st he rises at 8 P.M.

On the 1st, observing about half an hour after midnight, all the satellites will appear in close proximity to each other on the eastern side of the planet, whilst about the same time on the 4th, 12th, 18th, 19th, 21st, 25th, and 27th, three satellites only will be observable, the other satellite being out of view, either in front, behind, or in the shadow of Jupiter.

Saturn is in Sagittarius, being about an hour and a half to the west of Jupiter, and the next most conspicuous object to that planet looking southwards, rather low down.

The planet is exactly south at 1.20 A.M. on the 1st, and at 11.7 P.M. on the 31st. He is in opposition to the sun on the 18th at 1 A.M., on which date his apparent diameter is 17″·0. According to Mr. Whitmell, about opposition the earth is so situated with respect to the ring plane, that a suitably placed observer should be able to see a portion of the planet through the large rift in the ring known as the Cassini division, thus a portion of this usually dark interspace should appear bright, being illuminated by the planet's surface behind.

Uranus is in Capricornus, as shown by the chart given in last month's number. Near the middle of the month he is on the meridian at 9.30 P.M.

Neptune is out of range, rising just before dawn.

THE STARS.—About 9 P.M. near middle of the month:—

ZENITH .	Draco, Hercules, Bootes.
SOUTH .	Corona, Serpens, Ophiuchus, Libra, Scorpio.
EAST .	Delphinus, Aquila, Lyra, Capricornus; Sagittarius to the S.E.; Cygnus to the N.E.
WEST .	Great Bear, Cor Caroli, Leo, Virgo.
NORTH .	Ursa Minor, Cassiopeia; Capella on horizon.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of June Problems.

No. 4.

Key-move.—1. Q to B7.

If 1. . . .	K to Q5,	2. Q to B4ch, etc.
1. . . .	K to Kt5,	2. Q to B2, etc.
1. . . .	K to Kt3,	2. Q to K7, etc.
1. . . .	K to Q3,	2. Kt to Q3, etc.

No. 5.

The composer's intention (1. Q to KB5) is defeated by 1. . . P to K5, 2. Q × B, B to Q5! There is, however, an unintended solution by 1. B to Ksq, ch, and 2. B to QKt4.

No. 6.

Key-move.—1. Kt to B6.

If 1. . . .	P × B,	2. Kt to B4ch, etc.
1. . . .	B × R,	2. Q to B7ch, etc.
1. . . .	R to Bsq,	2. R to K3ch, etc.
1. . . .	K to Q3,	2. Q to B7ch, etc.
1. . . .	B × P,	2. Kt to B4ch, etc.
1. . . .	P × Kt,	2. Q to B7ch, etc.
1. . . .	P to Kt4,	2. R × R, etc.

[After other moves there are short mates; and after three moves of the Knight at Kt6 there are dual short mates. Evidently these are one and the same dual. Mr. Johnston alone appears to have discovered it. The composer of the Problem points out that if the board be turned round, White can mate in four moves by 1. R × R, P × B (best); 2. R to K4ch, etc. With this object the otherwise unnecessary Black Pawn at KR7 was added.]

SOLUTIONS received from W. Nash, 4, 4, 4; Alpha, 4, 4, 4; W. Jay, 4, 4, 4; G. Woodcock, 4, 3, 4; G. W. Middleton, 4, 4, 4; W. de P. Crousaz, 0, 4, 0; G. A. Forde, 4, 0, 0; "Tamen," 4, 4, 4; C. Johnston, 4, 4, 5; "Looker-on," 4, 4, 4; H. Myers, 4, 4, 4; A. F. (Rugby), 4, 0, 4; W. J. Land, 4, 4, 0; H. Boyes, 4, 4, 0; J. W. Dawson, 4, 4, 3.

[There may perhaps be some doubt as to whether a dual

mate on the second move should count as a dual *continuation*. I am inclined to think that it should, but am submitting the question to Mr. B. G. Laws. Should his opinion coincide with mine, Mr. Johnston's score will stand; otherwise a third and final arbitrator will decide the point.]

A. F. (Rugby).—As there is a mate on the move after 1. . . B to Q8, etc., duals resulting in mates on the third move would not count.

W. J. Land.—1. Kt × Kt appears to be answered by 1. . . P to Kt4.

H. Boyes.—See above. After 1. R × R, Kt × R; 2. B to Kt3, B × B, there is no mate.

J. W. Dawson.—The rule printed in the April number reads:—"When a problem has more than one key, no points will be given or deducted for claiming duals." The reason is that when a problem is "cooked," it is immaterial to the judges whether its solutions contain duals or not. Many of your claims for duals in No. 6 are incorrect, but as most of them are for cases in which there is a short mate, no points have been deducted for such claims. One point, however, must be deducted for the claim of a dual after 1. . . P × B. Neither 2. R × R, nor 2. P to B4ch, will meet the case.

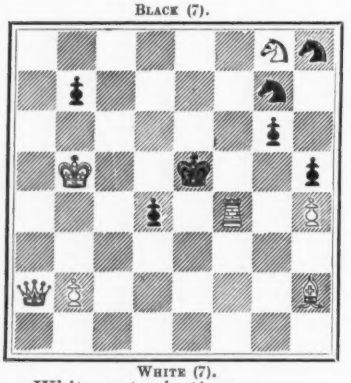
Composer of "Tubby."—Your problem must be disqualified. Castling as a key-move is not legitimate, as there is no proof that White has a legal right to castle.

PROBLEMS.

No. 7.

"Nemo saltat sobrius."

BLACK (7).



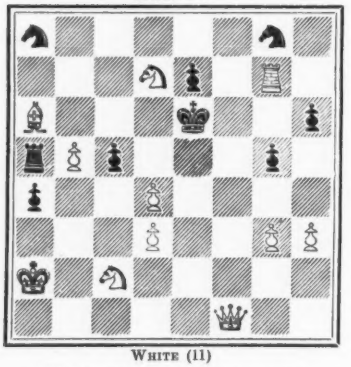
WHITE (7).

White mates in three moves.

No. 8.

"Poor Pink."

BLACK (9).



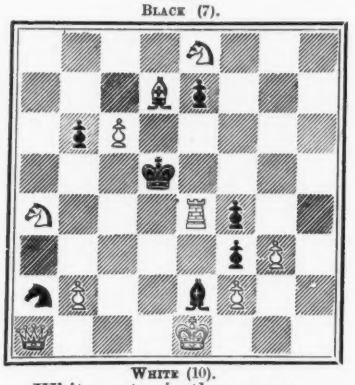
WHITE (11)

White mates in three moves.

No. 9.

"Satis."

BLACK (7).



WHITE (10).

White mates in three moves.

After the very satisfactory entry for the Problem Tourney, the number of competitors in the Solution Tourney comes as a disappointment. We can only guess that many of the readers of this page either found the May problems exceptionally difficult, or decided that the solving of three three-move problems a month was too much for them. I cannot alter the number at present, but after the end of the year, and in future solution tourneys, the number of three-move problems will be diminished.

SPECIAL NOTICE.

All claims for incorrect scoring of points must be sent in within ten days of the first day of the month of publication. After that date solutions will be destroyed, and claims for altered scores cannot be considered.

CHESS INTELLIGENCE.

Mr. F. J. Marshall, the well-known American expert, has defeated, in short matches, two of our strongest amateurs. Mr. R. Loman lost by four games to two, and Mr. W. Ward by the same majority. Mr. Ward was the winner this year of the City of London Club Championship, Mr. T. F. Lawrence being second, and Messrs. T. B. Girdlestone and H. W. Trenchard bracketed third and fourth.

A correspondence match between Yorkshire and Kent, with 50 players a side, resulted in a win for Yorkshire by 28½ to 21½. At board No. 1, Mr. G. A. Schott, of Bradford, won a brilliant game against Mr. O. C. Muller.

The Open Amateur Tournament of the Kent County Association resulted as follows:—First prize, R. Loman, 7; second, O. C. Muller, 6; equal third, fourth and fifth, R. P. Michell, G. A. Thomas and G. E. Wainwright, 5½. There were five other competitors.

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